Vol. VII

TRANSCRIPT OF RECORD

(Pages 3085 to 3587)

Supreme Court of the United States

OCTOBER TERM, 1943

No. 392

UNIVERSAL OIL PRODUCTS COMPANY,
PETITIONER,

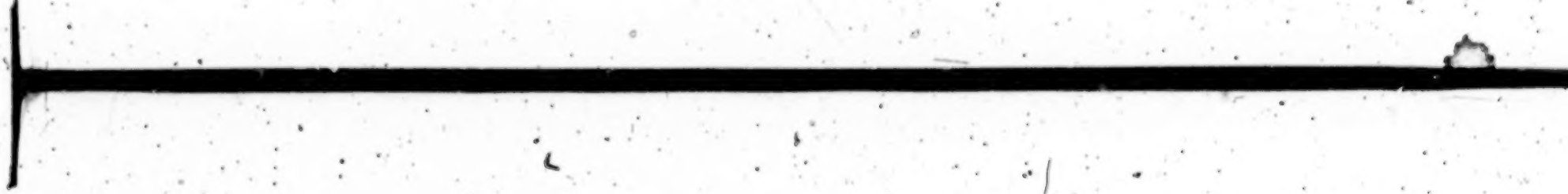
vs.

GLOBE OIL & REFINING COMPANY

ON WRIT OF CERTIORARI TO THE UNITED STATES CIRCUIT COURT OF APPEALS FOR THE SEVENTH CIRCUIT

PETITION FOR CERTIORARI FILED SEPTEMBER 28, 1943.

CERTIORARI GRANTED NOVEMBER 15, 1943.



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For the Seventh Circuit

No. 7912

UNIVERSAL OIL PRODUCTS COMPANY,
Plaintiff-Appellant,

vs.

GLOBE OIL & REFINING COMPANY,
Defendant-Appellee.

FILED
APR 1 1942
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Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

THE BLAKELY-WARREN PRINTING COMPANY, 810 WEST JACKSON, CHICAGO

DOCKETED JAN. 14, 1942.
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In the

United States Circuit Court of Appeals

For the Seventh Circuit

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UNIVERSAL OIL PRODUCTS COMPANY,
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C. P. DUBBS.

PROCESS OF CONVERTING HYDROCARBONS.

APPLICATION FILED MAR. 19, 1919.

1,392,629. Patented Oct. 4, 1921.

2 SHEETS—SHEET 1.

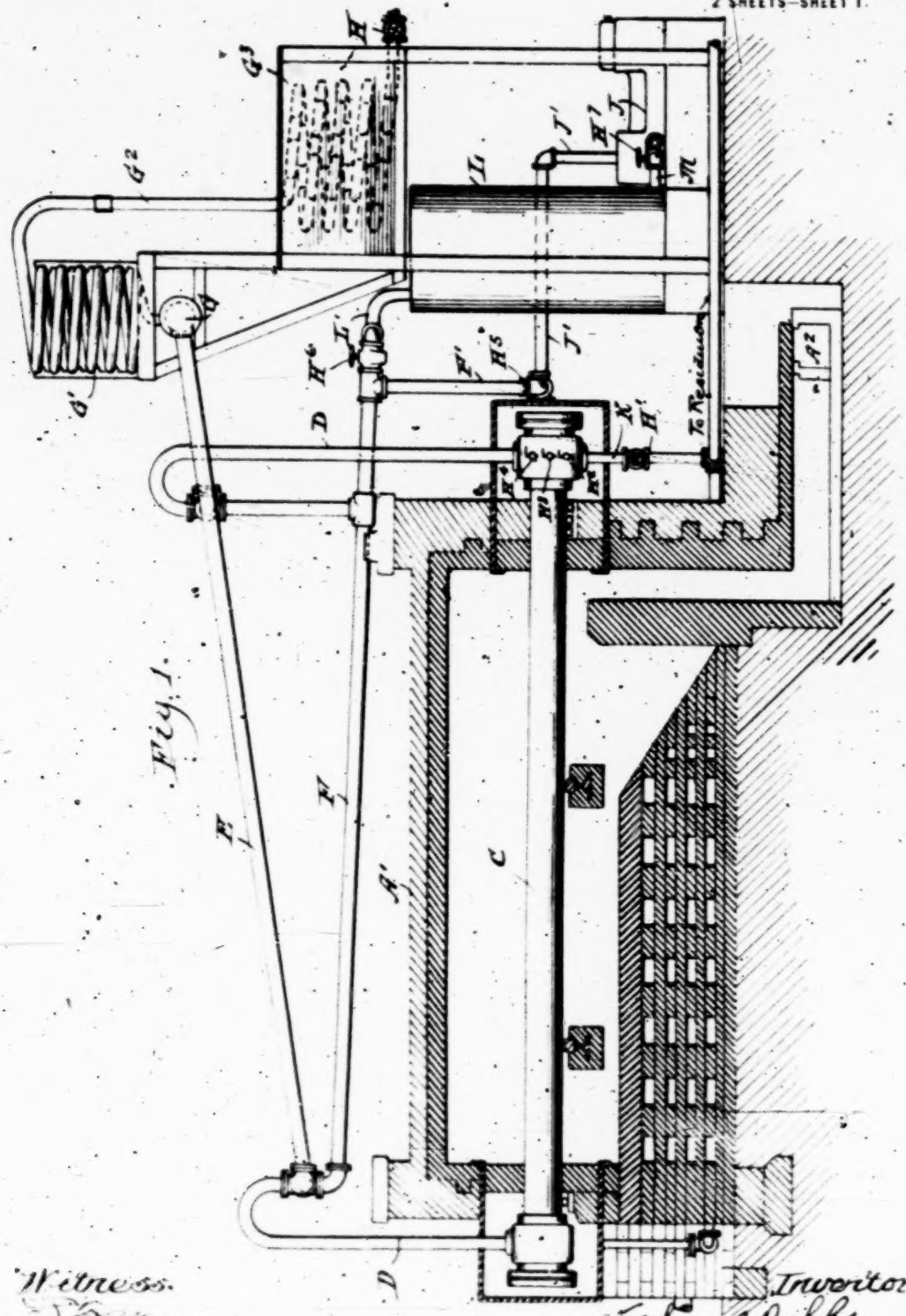

Fig. 1.

Witness.

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By Frank L. Belknap Atty.

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2 SHEETS—SHEET 2.

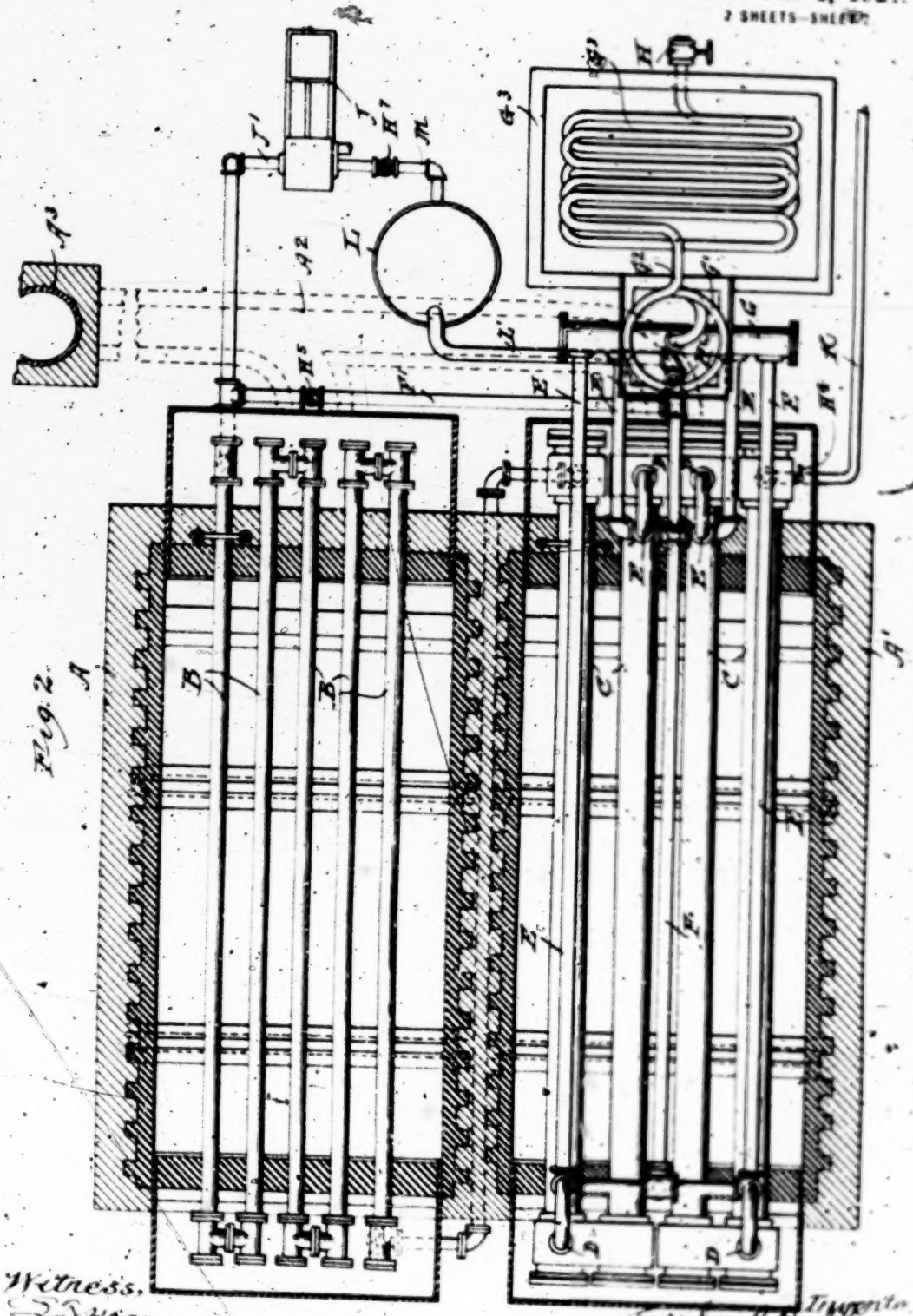


Fig. 2.

Witness,
[illegible]

Inventor
Carlton P. Dubbs
By Frank L. Belknap
Atty

UNITED STATES PATENT OFFICE.

CARBON P. DUBBS, OF WILMETTE, ILLINOIS.

PROCESS OF CONVERTING HYDROCARBONS.

1,392,629. Specification of Letters Patent. Patented Oct. 4, 1921.

Application filed March 19, 1919. Serial No. 283,673.

To all whom it may concern:

Be it known that I, CARBON P. DUBBS, a citizen of the United States, residing in the city of Wilmette, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Processes of Converting Hydrocarbons, of which the following is a specification.

This invention relates to improvements in processes of converting hydrocarbons and refers more particularly to an improved form of cracking process of the continuous type. Among the salient objects of the invention are to provide a process in which the oil is continuously fed through the cracking zone and thence through the vapor zone, and a portion of the generated vapors condensed and returned to the inlet side of the cracking zone for further treatment; to provide a process of the character above referred to in which the carbon containing residue is continuously removed from the cracking zone while the reflux condensate is returned to the cracking zone for further treatment substantially free from carbon; to provide a process which permits of the apparatus being operated for an extended period without the necessity of cleaning and in which that part of the system containing the precipitated carbon, is free from subjection to any excessive heat; to provide a process in which the reflux condensate is continuously removed from the refluxing condensing apparatus and returned to the inlet side of the system; to provide a process in which the vapors not initially condensed are finally caused to pass through a single passage for a secondary condensing action and in general to provide an improved process and also a novel apparatus of the character referred to.

The claims of the present invention are directed more particularly to the process, although it is to be understood that the apparatus itself is novel.

In the drawings:

Figure 1 is a sectional side view.

Fig. 2 is a sectional plan view.

Describing the apparatus, A and A^1 are the furnaces. A^2 the flue tunnel, A^3 the stack.

B are the cracking tubes. C are the vaporizing tubes. D are the vapor tubes connected with the vaporizing tubes C. E are the slanting portions of the vapor tubes. F is the drainage line from the vapor tubes to the B tubes situated in the furnace A, connected by line F^1 into line J^1 and on line F^1 is valve H^5. G is the manifold connecting with the slanting vapor tubes E and also connecting with aerial condenser G^1 which latter connects with vapor line G^2 to water cooled condenser G^3 and on which is valve H. J is a standard high pressure liquid pump connected with any source of supply not shown. J^1 is the discharge from said pump into coils B. K is the residuum line connected with the 10" tube and positioned in it pressure valve H^1. H^2, H^3, H^4 are try cocks.

Describing the operation of the process, the material to be treated is drawn from any suitable source by means of the pump J and discharge therefrom through line J^5 into and through tubes B and during the time they are passing through said tubes, they are subjected to sufficient heat to cause the desired amount of cracking. Said oil is then passed into the tubes C which are only partially filled with the oil and as the oil passes through these tubes, there is a liberation of vapors from same and which vapors pass up through the vapor tubes D, E and into header G and through aerial condenser G^1, through line G^2, through water condenser G^3 and discharged through pressure regulating valve H. The portion of vapors condensed while passing through vapor lines E, manifold G and aerial condenser G^1 are automatically drained back through these lines into drainage line F and from there through line F^1 enter into line J^1 and back into the heating tubes B. The residue left in the coils C is drawn off through line K through pressure regulating valve H^1 to any suitable place. Pressure is maintained on the entire apparatus and is regulated by the valve H.

A light fire may be maintained under the tubes C as shown in the drawings or said tubes may be heavily insulated with cel-o-cel insulating material or any other well known insulating material to prevent loss of heat by radiation and thereby dispense with the fire under the tubes C. The level of the liquid in the tubes C is ascertained by try-cocks H^2, H^3, H^4 and the level controlled by valve H^1. The per cent of vapors generated from the oil as it passes through the tubes C will depend on the amount of heat acquired by said oil while passing through the 4" coils.

I do not wish to confine myself to the above described operation except as to illustrate the principal involved and which principal may be applicable in various arranged apparatus.

For instance, the reflux distillates may be returned to the heating coils B directly or indirectly, part of them direct and part of them indirect. For instance, instead of returning the reflux condensate direct to the tubes marked B by means of line F^1, the same may be discharged into a tank marked L through line L^1 by opening the valve H^6 which otherwise would remain closed and closing the valve H^5 on line F^1 or part of the condensate may be returned directly back to the tubes B through line F^1 by regulating the opening of valve H^5 and the rest discharged to tank L through line L^1 by regulating the opening of valve H^6. Tank L may be maintained under pressure or not and it may contain the raw material that is being treated or contain wholly the reflux distillate and from this tank the contents of same are fed to the tubes B through line M into pump J and from there discharged into line J^1.

It will be noted that the reflux condensate in all cases is trapped off from the vapor lines in such manner as to prevent their returning direct to the vaporizing tubes C.

An illustrative run of the described apparatus, in accordance with my process, is as follows:

Gas oil from mid continent crude oil, such as Kansas, or Oklahoma, oils of 32 to 36 Baumé gravity is taken and continuously supplied to the pump J and thence to the 4 inch coils B which are subjected to a temperature of 750° to 860° F. The heated oil then passes to the 10 inch coils C which are maintained about half full of oil and wherein vaporization takes place. The residue is constantly drawn off through the pipe K to a suitable storage. The vapors pass up through the lines D to the pipe E into the manifold G and from thence into the aerial condenser G^4 where the heavier distillates are condensed and the lighter distillates pass on to the water cooled condenser G^3. The reflux condensation is diverted and returned to the inlet side of the tubes B, either directly through the lines F, F', or indirectly through the line F, tank L and line M to the pump. A pressure of approximately 100 lbs. to the square inch is maintained on the oil during treatment which is caused by the pressure of the generated vapors. This pressure is regulated by the valve H.

The gravity of the distillate discharge from the water cooled condenser is about 52 to 56 Baumé and in quantity is approximately somewhat more than half of the gas oil subjected to treatment.

I claim as my invention:

1. A process of converting relatively heavy into lighter hydrocarbons, consisting in passing a stream of oil through a zone where the oil is heated to a cracking temperature but without substantial vaporization, passed thence to and through a zone where vaporization takes place, removing the vapors, subjecting them to reflux condensation, returning reflux condensate for further cracking, removing the residue, after said vaporization, from the system without permitting intermingling of any substantial portion thereof with the oil in the heating zone and maintaining a pressure upon the material during distillation.

2. A process of converting heavy into lighter hydrocarbons consisting in passing in an advancing direction a stream of oil through a zone where the oil is heated to the cracking temperature but substantial vaporization prevented and thence to and through a zone where vaporization takes place, removing the vapors and condensing them, returning a portion of the condensates to the heating zone for further treatment, removing the residue after said vaporization from the system without permitting contact or intermingling of any substantial portion thereof with the oil in the heating zone and maintaining a vapor pressure upon the material under treatment during distillation and condensation.

3. A process of converting heavy into lighter hydrocarbons consisting in passing in an advancing direction a stream of oil through a heating zone where the oil is heated to the cracking temperature but substantial vaporization prevented and thence to an enlarged chamber where vaporization takes place, removing the vapors from said chamber and condensing them and returning a portion of the condensates to the heating zone for further treatment, withdrawing substantially continuously the residue from said chamber and discharging the same entirely apart from the feed of oil to the heating zone and maintaining a vapor pressure upon the material under treatment during distillation and condensation.

4. A process of converting heavy into lighter hydrocarbons consisting in passing in an advancing direction a continuous stream of oil through a heating zone where the oil is heated to the cracking temperature but substantial vaporization prevented and thence to a chamber where vaporization takes place, discharging from the chamber substantially continuously a quantity of the residue proportional to the amount of oil supplied to the heating zone and said vaporization, condensing the vapors and returning a portion of the condensates to the stream of oil for re-treatment in the heating zone and maintaining a vapor pressure upon

the material under treatment during distillation and condensation.

5. A continuous process for cracking hydrocarbons consisting in passing the same in a stream in an advancing direction from an inlet point to a discharge point separated and entirely disassociated from the inlet point, subjecting the material in the first stage of its travel to a cracking temperature while preventing substantial vaporization, affording a vaporization space above the stream during the second stage of the travel thereof to said discharge point, taking off the vapors from said vapor space and subjecting them to a condensing action, discharging into the stream at a point remote from that where vaporization occurs a portion of the condensates and, maintaining a vapor pressure on the material under treatment during distillation and condensation.

6. A process of converting heavy into lighter hydrocarbons consisting in passing a stream of oil through a horizontally disposed conduit located in a heating zone, said oil substantially filling the conduit and being heated to the cracking temperature in its passage therethrough, passing the oil from said conduit into a second conduit of greater diameter than the first and horizontally disposed with its bottom in substantially the horizontal plane of the bottom of the first-named conduit whereby a vapor space is provided above the level of the oil wherein vaporization takes place, drawing off said vapors and subjecting them to a condensing action, returning a portion of the condensates to the first-named conduit, drawing off from the second conduit the residue after vaporization and maintaining upon the material under treatment during distillation and condensation a substantial pressure of the vapors generated.

7. A process of cracking oil consisting in continuously passing a stream of oil through a series of tubes seated in a cracking zone where the oil is heated to the cracking temperature but substantial vaporization prevented, and thence to an enlarged vapor chamber where vaporization takes place, removing the vapors from said chamber, subjecting them to an initial condenser where a portion of the vapors are condensed, subjecting the uncondensed portion of the vapors to a final condensation, returning the condensate from said initial condensation to the inlet side of the cracking tubes and continuously drawing off the residue from the vapor chamber and preventing it from returning to the cracking zone and maintaining a pressure on the oil during treatment.

8. A process of cracking oil consisting in progressively passing the oil through a heating zone where the oil is heated to the cracking temperature but substantial vaporization prevented and then passing the heated oil through a vaporizing zone, forcing the carbon containing residue out of the system and preventing it from coming in contact with the incoming charging stock, taking off vapors from the vapor zone and condensing them and returning condensate therefrom to and mixing it with the fresh charging stock which is being passed through said zone.

9. The process for treating hydrocarbon oil by heating it to a cracking temperature and condensing the condensable products volatilized therefrom under pressure, consisting in raising the oil to a cracking temperature without substantial vaporization in a heating zone, passing the heated oil to a second zone where vaporization occurs, removing the vapors and subjecting them to condensation, subjecting a portion of the condensate to further cracking, taking off the carbon containing residuum from the second zone without permitting access of any substantial portion thereof to the heating zone, and maintaining a pressure upon the materials under treatment, substantially as described.

CARBON P. DUBBS.

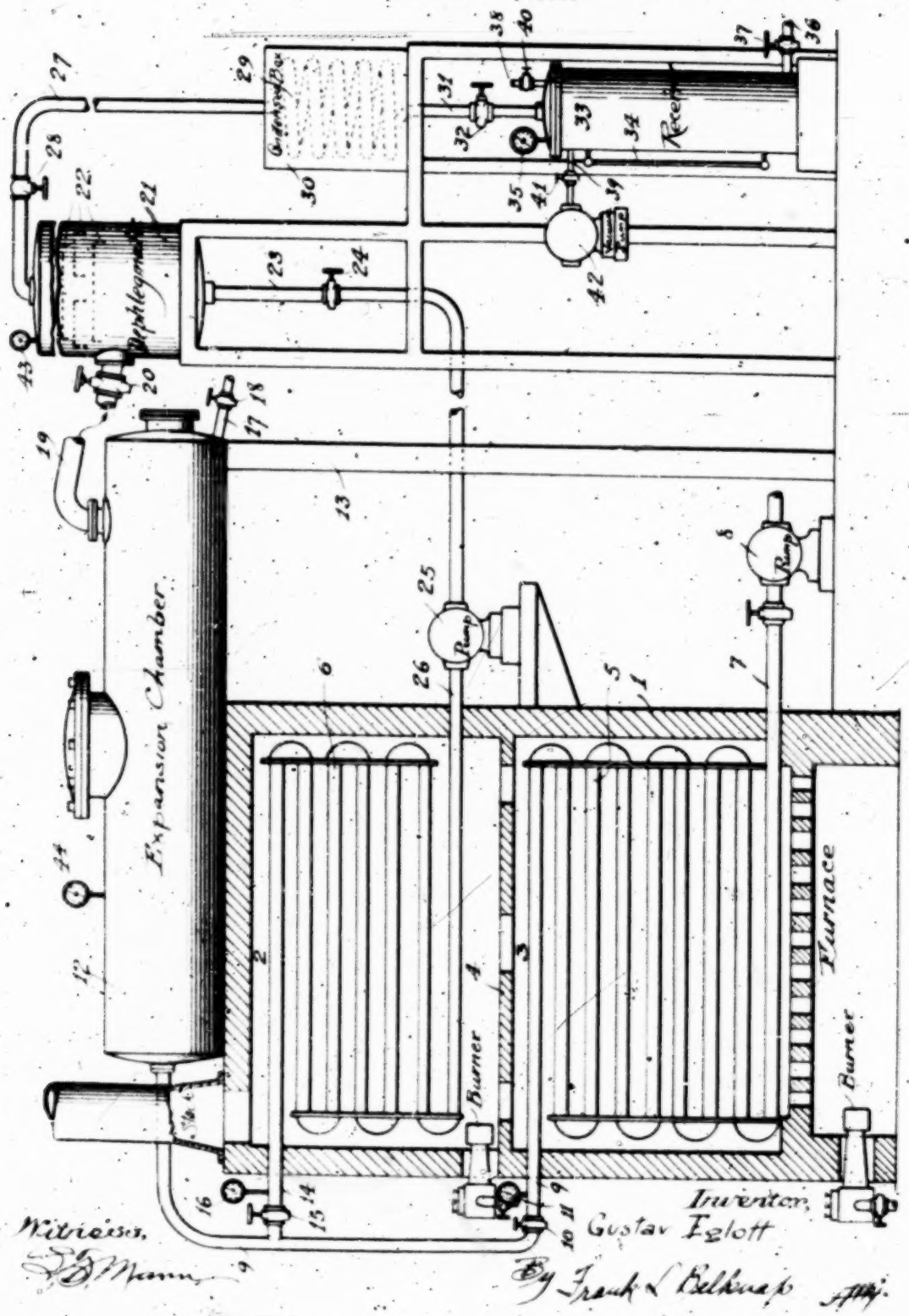
3094

May 12, 1925. 1,537,593

G. EGLOFF

PROCESS FOR CRACKING OIL

Filed Dec. 9, 1920



Patented May 12, 1925. 3095 1,537,593

UNITED STATES PATENT OFFICE.

GUSTAV EGLOFF, OF INDEPENDENCE, KANSAS, ASSIGNOR TO UNIVERSAL OIL PRODUCTS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF SOUTH DAKOTA.

PROCESS FOR CRACKING OIL.

Application filed December 9, 1920. Serial No. 429,319.

To all whom it may concern:

Be it known that I, GUSTAV EGLOFF, a citizen of the United States, and residing in the city of Independence, county of Montgomery, in the State of Kansas, have invented certain new and useful Improvements in Processes for Cracking Oil, of which the following is a specification.

This invention relates to improvements in process and apparatus for cracking oil, and refers more particularly to a process in which the oil is distilled under heat and pressure, certain of the vapors subjected to reflux condensation and subjected to further cracking, the object in the present instance being to subject the reflux condensate to different conditions of temperature or pressure or both than that to which the raw oil is subjected. Another object of the invention is to, if desired, subject part of the apparatus to vacuum action.

In the drawings, the single figure designates a view partly in vertical section and partly in side elevation of my improved apparatus.

Referring to the drawings, 1 designates a furnace, provided with combustion chambers 2 and 3, separated preferably by a foraminated bridge wall inside. In the respective combustion chambers are mounted the heating coils 5 and 6, each of which may take the form of a continuous length of several hundred feet of two to eight-inch pipe. The lower coil 5 is connected by feed line 7 to charging pump 8, leading to any suitable source of raw oil supply, as for example fuel oil or heavy asphaltic crudes such as California or Mexican crudes containing in themselves little gasolene, or the like. The delivery side of the coil 5 is connected by transfer line 9, having throttle valve 10 and pressure gauge 11, to the end of an elongated horizontally disposed expansion chamber 12. This expansion chamber may for example be 68 inches in diameter and 40 to 60 feet long. It is located outside the fire zone and suitably supported above the furnace by means of supports 13. The delivery side of the coil 6 is connected by auxiliary transfer line 14, having throttle valve 15 and pressure gauge 16, to the main transfer line 9. The expansion chamber 12 is provided with residue draw off pipe 17, having throttle valve 18, and with a vapor outlet pipe 19, having throttle valve 20, leading to the lower side of the dephlegmator 21. The dephlegmator 21 is provided with a series of baffle like plates 22, and at its lower side is connected to reflux return line 23, having throttle valve 24, and leading to reflux oil pump 25 interposed in the feed line 26 leading to the inlet side of the heating coil 6. The upper end of the dephlegmator is connected by vapor line 27, having throttle valve 28, to the top of condenser coil 29, seated in condenser box 30. The lower end of the coil 29 is connected by pipe 31, having throttle valve 32, to the upper part of receiver 33. This receiver 33 has liquid level gauge 34, pressure gauge 35, liquid draw off pipe 36, controlled by valve 37. It is also provided with two gas outlet pipes 38 and 39, controlled by throttle valves 40 and 41 respectively. The pipe 39 is connected to a vacuum pump 42, whereby a vacuum may be maintained on the receiver, condenser, dephlegmator and vapor chamber, or on the receiver alone or receiver and condenser alone, or receiver, condenser and dephlegmator alone. This is accomplished by suitably regulating the various valves shown. The dephlegmator is provided with pressure gauge 43 and the vapor chamber with pressure gauge 44.

The process may be carried out as follows:

Fuel oil, as for example fuel oil from the Wayside Kansas field of say 25 degrees Baumé, may be heated to a temperature of say 700 degrees F., and subjected to a pressure of say 150 pounds in the heating coil 5, and delivered in substantially liquid phase through the insulated transfer line 9 to the expansion chamber 12. This expansion chamber may be maintained under a pressure of say 135 pounds. The reflux condensate may be pumped back by pump 25 to the heating coil 6, and there subjected to a pressure of 175 pounds and a temperature of say 770 degrees F. It is delivered in substantially liquid phase to the vapor chamber 12.

It will be thus seen that the reflux condensate is continuously subjected to recracking, but at different conditions of temperature of pressure, or both, than that to which the raw oil is subjected. A process may be carried out in the apparatus in the manner just above described, except that the dephlegmator, condenser and receiver, in

stead of being under a pressure of 135 pounds as in the first case, may be subjected to a vacuum through suitably regulating the vacuum pump, opening the valve 41, closing the valve 40, and regulating the valve 20, valves 28 and 32 being also open.

I claim as my invention:

1. A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs, in subjecting the evolved vapors to reflux condensation to condense the heavier vapors, in passing the reflux condensate in an advancing stream through a heating zone where it is subjected to a cracking temperature, in delivering the said heated condensate to the enlarged zone, in simultaneously heating an independent advancing stream of charging stock to a cracking temperature, in delivering the said heated charging stock to said enlarged zone, and in maintaining a superatmospheric pressure on both of said oil streams and on the body of hydrocarbons in said enlarged zone.

2. A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs, in subjecting the vapors to reflux condensation to condense the heavier fractions of the vapors, in passing reflux condensate in an advancing stream through a heating zone where it is subjected to a cracking temperature, in delivering the heated condensate to said enlarged zone, in simultaneously heating an independent stream of charging stock to a cracking temperature while under a superatmospheric pressure, in introducing said heated charging stock to said enlarged zone in which zone the charging stock and heated condensate physically commingle, and in maintaining the stream of reflux condensate while being heated under a superatmospheric pressure exceeding the pressure maintained on the stream of charging stock.

3. A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization is permitted, in subjecting the vapors to reflux condensation to condense the heavier fractions thereof, in passing the resulting reflux condensate in an advancing stream through a heating zone where it is subjected to cracking conditions of temperature and pressure, in delivering said heated condensate to the enlarged zone, in simultaneously heating an independent advancing stream of charging stock to be delivered to said enlarged zone at a temperature lower than the temperature of the stream of reflux condensate, but sufficiently high to cause a substantial vaporization of the charging stock in said enlarged zone, and in introducing said heated charging stock to said enlarged zone.

4. A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs, in subjecting the vapors to reflux condensation to condense the heavier vapors, in passing the reflux condensate in an advancing stream through a heating zone where it is subjected to cracking conditions of temperature and pressure, in delivering the heated condensate to said enlarged zone and simultaneously heating an independent stream of charging oil for delivery to said enlarged zone to a temperature sufficient to cause a substantial vaporization thereof in said zone, and in introducing said heated charging oil to the enlarged zone.

5. A process of oil conversion, consisting in maintaining a body of heated hydrocarbons in an enlarged zone where substantial vaporization occurs, in subjecting the vapors to reflux condensation to condense the heavier vapors, in passing the reflux condensate in an advancing stream through a heating zone where it is subjected to cracking conditions of temperature and pressure, in delivering heated condensate to said enlarged zone, and simultaneously heating an independent stream of charging oil for delivery to said enlarged zone to a temperature sufficient to cause a substantial vaporization thereof in said zone, in introducing said heated charging oil to the enlarged zone, and in withdrawing unvaporized oil from said enlarged zone without permitting the same to again enter either of said oil streams.

GUSTAV EGLOFF.

3098

Feb. 14, 1928.

Re. 16,877

O. BEHIMER

PROCESS FOR MAKING GASOLINE

Original Filed Nov. 21, 1918

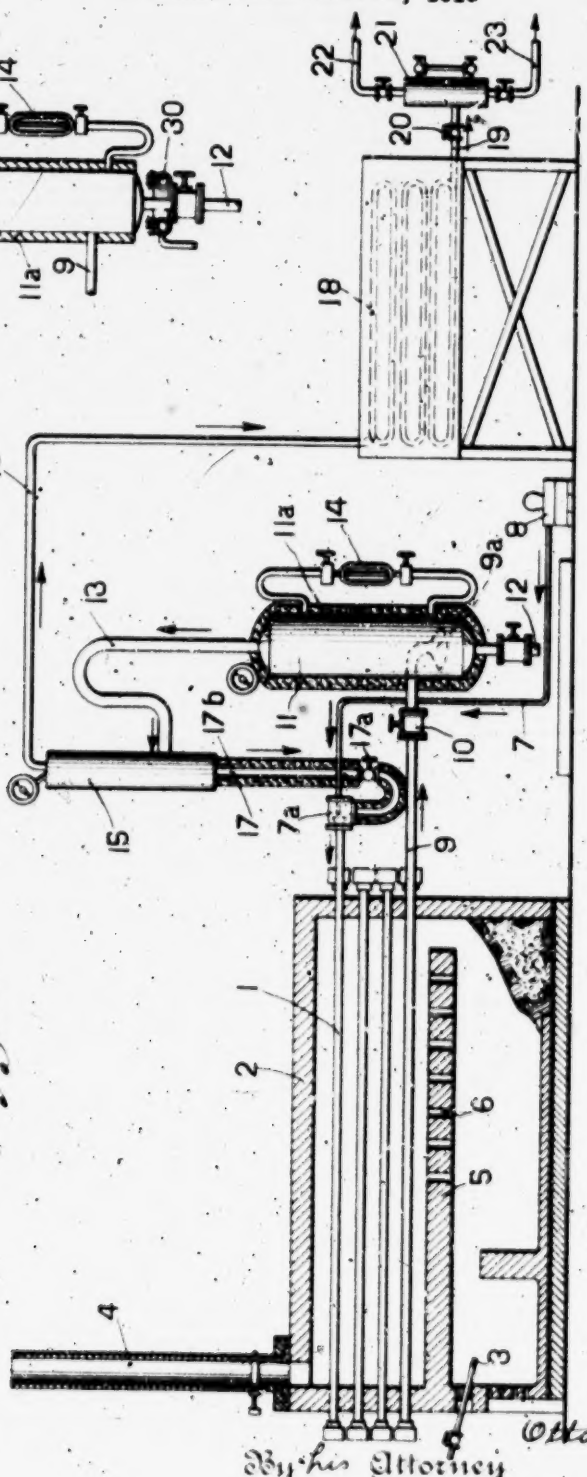


Fig. 2.

Fig. 1.

Inventor
Otto Behimer
By his Attorney
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Reissued Feb. 14, 1928.

3099 Re. 16,877

UNITED STATES PATENT OFFICE.

OTTO BEHIMER, OF PORT ARTHUR, TEXAS, ASSIGNOR TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

PROCESS FOR MAKING GASOLINE.

Original application filed November 21, 1918, Serial No. 263,562. Divided and application filed April 6, 1923, Serial No. 630,242. Divided and application filed August 13, 1925, Serial No. 49,962. Original No. 1,585,496, dated May 18, 1926. Application for reissue filed June 24, 1927, Serial No. 201,273, and in Canada December 3, 1921.

This invention relates to methods of making condensable light oils, such as gasoline. More particularly it relates to certain novel improvements in the cracking of hydrocarbons whereby higher boiling hydrocarbons are decomposed into those of lower boiling point.

This application is a division of my copending application, Serial No. 630,242, filed April 6, 1923, which itself is a division of my copending application, Serial No. 263,562, filed November 21, 1918.

In prior methods of cracking hydrocarbon oils, considerable difficulty has been experienced on account of carbon formations, which occur on the sides of tubes and stills exposed to the heat required to carry on the cracking operation.

It is a broad novel feature of the herein disclosed process that substantially all of the cracking operation occurs in a vessel to which no external heat is applied, except at such times and in such quantities as are necessary to compensate for heat losses, the oil prior to its introduction to such vessel having been subjected to a high degree of cracking heat and the excess heat of the oil itself being used to effect its own decomposition. As a consequence, I avoid substantial carbon formation of the destructive character which has proved such an impediment to prior systems. The removal of the cracking operation from the heating zone also reduces the danger from fires such as frequently occur where cracking is carried on in highly heated stills and coils exposed to direct heat.

More specially my process preferably embodies a novel cyclic system in which a circuit of oil is constantly maintained under varying liquid and vapor phases. The oil to be treated on entering this circuit is subjected to a high degree of heat, but the time element is so controlled with respect thereto that there is comparatively little decomposition and deposition of carbon while it is exposed to this external heat, the oil being rapidly removed from the heating zone and conducted to the cracking zone, where without necessarily being subjected to additional heat, it undergoes a molecular decomposition whereby carbon and light products are formed and liberated. It will be understood that oil cracking or conversion is dependent not only upon the relative conditions of pressure and temperature but also upon the time element with respect thereto, that is, the necessary pressure and temperature must be maintained for a sufficient period of time to enable the molecular decomposition or conversion to take place. According to the present invention, this time factor is so controlled, by regulating the rate of heating the oil passing through the heating zone that the temperature thereof is progressively raised in transit and reaches the desired cracking temperature near the end of the heating coil at about the time or a little before the oil emerges therefrom. Thus, although the oil is subjected to cracking heats in the heating zone, this temperature is attained only just previous to the exit of the oil therefrom, and therefore, the oil leaves the heating coil before any substantial decomposition and incident deposition of carbon takes place. Subsequently, the highly heated oil in a state of incipient decomposition, is delivered to the cracking zone, where the desired temperature and pressure conditions are continuously sustained and the cracking of the oil and the incident decomposition of carbon are effected. The bulk of the carbon is removed from the circuit by withdrawing from the cracking zone, portions of the residual oil. Although the process, in its broad conception, is complete at this stage of the operation, the light products preferably continue the cycle, leaving the cracking zone in the form of vapor and gas. These vapors and gases are then subjected to a reduction in temperature, whereby the heavier constituents thereof, such as kerosene, are condensed. The condensate preferably is combined with the charging oil entering the heating zone, thus completing the cycle. The constituents of the desired volatility are removed from the circuit and condensed. The outlets from the circuit are so controlled that the entire system is maintained under a pressure sufficient to insure the desired molecular transformation.

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My process is to be distinguished from those of the prior art, in which a circuit of liquid residuum is kept in circulation. When such oil is kept in circulation, considerable quantities of carbon are formed, owing to the readiness with which this type of oil carbonizes when exposed to high temperatures, the carbon forming in fine particles in the oil, and wherever it comes in contact with the heated metal surfaces, it attaches itself thereto and builds up deposits, which often cause the choking of tubes and coils. It also crystalizes the metal surfaces, thereby decreasing the tensile strength of the metal and causing the bulging and breaking of such surfaces. Any residual oil resulting from the cracking operation will necessarily contain a considerable amount of heavy polymerization products and carbon held in suspension in the oil, and to circulate such a residue through heated tubes is to continually pass into or produce in such tubes a large amount of free carbon. In my system, I do not circulate a residuum, but instead keep the residual oil removed from the application of external heat and withdraw the heavier portions thereof, which contain the bulk of the carbon, from the cycle at the cracking zone, and continue the cycle by means of the vapor generated, which contains the condensable product desired and also certain heavier vaporous constituents which are used to complete the cycle. By removing the heavier residuum from the cycle, I keep the circuit free from this source of carbon formation, and since I conduct substantially all of the cracking in a vessel to which either no external heat is applied or only a small quantity of heat is applied to maintain the requisite temperature conditions, I am thus able to effectively remove the carbon formed.

In cracking oil for gasoline, there is generally formed a considerable quantity of vapors heavier than gasoline, which may be generally designated by the term, kerosene. I preferably employ these heavier vapors as a carrier for the lighter vapors; they assist in maintaining a current of vapor by which the gasoline is removed from the cracking zone to a separator where the kerosene vapors are condensed and removed from the gasoline vapors which pass on to the condenser. The kerosene condensate, preferably at a temperature, not materially below its boiling point, is injected or otherwise suitably forced into the heavy oil charge entering and flowing through the heating tubes whereby a foamy agitated mixture is produced by the acceleration of the circulation in the heating tubes resulting from the increased volume of oil therein, thereby preventing the settling and flow of the heavier portions of the oil along the bottom of the highly heated tubes and the consequent local overheating and carbonization of the oil, thus keeping the tubes substantially free from any slight carbon formations. These kerosene constituents are an excellent mechanical conductor of heat, and there is thus produced a heat cycle which materially assists in maintaining the proper temperatures in the heating and cracking zones. By maintaining these bodies in constant circulation, the kerosene constituents, which under existing methods have been found so difficult to decompose into lighter products, are, in my system, ultimately reduced to gasoline.

I have devised certain novel apparatus which is adapted for carrying out my process, and illustrates the preferred form thereof in the drawing in which,

Figure 1 is a diagrammatic elevation of said apparatus;

Figure 2 is a detail view of a modified cracking drum which may be substituted for that of Figure 1.

It will be understood that other apparatus besides that illustrated may be used in carrying out my process.

Referring to Figure 1 of the illustrative drawings, a tubular heating coil 1 is located in a furnace 2, having a burner 3 and a stack 4. As shown for illustrative purposes, the coil 1 comprises a plurality of horizontally disposed rows of tubes extending through the furnace and placed the one above the other. The adjacent ends of each alternate pair of tubes in each horizontal row are conveniently connected together by horizontally positioned return bends or fittings to form horizontal coils. The several horizontal coils thus arranged are conveniently connected together at their right hand ends by vertically disposed return bends or fittings, as shown in Figure 1, to form a single elongated and continuous heating coil through which the oil flows and is heated to the required degree. This coil is of extended length and restricted cross-section and has a relatively large and effective heating surface whereby the stream of oil passing therethrough is enabled to efficiently absorb heat and reach a high temperature with rapidity. A checkered brick baffle 5 having openings 6 may serve to distribute the heat evenly over the coil. A fresh oil charging line 7, having a jet or injector 7^a, extends to a pump 8, which is connected to a suitable source of oil supply (not shown). The pipe 9, having a valve 10, extends from the heating coil 1 to an enlarged cracking drum or chamber 11, within which it may terminate in a distributor 9^a. This distributor 9^a may be of any suitable form to thoroughly distribute and diffuse the charging oil throughout the body of oil in the drum whereby an intimate contact of the highly heated charging oil with the body of oil in the drum is effected. The cracking drum is preferably provided with a

jacket 11ª of suitable insulating material to protect it against heat radiation, and is equipped with a valved draw-off 12, a vapor outlet 13, and an oil gauge 14. The vapor outlet 13 extends to a separator 15, having a vapor outlet 16, and a condensate outlet 17. The vapor line 16 terminates in a water-cooled condenser coil 18, having an outlet 19 equipped with a regulatable pressure valve 20. If desired, the valve 20 may be placed in the vapor line 16 but I prefer to maintain the pressure in the heating coil, cracking drum and separator through the condenser. The outlet 19 terminates in a collecting tank 21, having a valved gas outlet 22 and a valved distillate outlet 23. The condensate line 17, which is preferably insulated, as indicated at 17ᵇ is equipped with a valve 17ª and is connected to the charging line 7 at the jet 7ª.

In conducting the process with the apparatus illustrated, the oil to be treated is forced through the charging line 7 under considerable pressure, and is rapidly flowed through the heating coil 1, where it is heated to the desired cracking temperature. Preferably this temperature is somewhat higher than the temperature at which it is desired to conduct the cracking operation and may or may not result in substantial vaporization. The oil on being forced through the coil acquires a high cracking temperature, but on account of the rapidity of its flow, decomposition is only in the incipient stages when the oil is discharged through the pipe 9 into the heat insulated cracking drum 11 where a constant body of oil is maintained at a cracking temperature under pressure. The distributor 9ª, if employed serves to discharge the oil into the cracking drum in a wide stream, thus thoroughly mixing the hot oil with the liquid body of oil maintained in the drum and diffusing the heat therethrough. This heat diffusion is materially aided by using a distributor with serrated edges. The rapid flow of the oil through the coil where it is closely confined is here suddenly retarded, as the oil enters the drum which is of ample volume. Thus, the excess heat of the oil operates to maintain the body of oil at the desired cracking temperature and molecular decomposition and distillation are carried on vigorously, the higher boiling hydrocarbons continually breaking up into hydrocarbons of lower boiling point. The vapors and gas generated gather in the upper part of the cracking drum and pass out through the vapor outlet 13 to the separator 15, where there is effected a separation of hydrocarbons of desired volatility from those of less volatility. The hydrocarbons of the desired volatility pass out through the vapor line 16, by which they are conducted to the condenser 18, where they are condensed, and the condensed distillate is either intermittently or preferably continuously allowed to run into the collecting tank 21.

The temperature in the air condenser 15 is such that the less volatile hydrocarbons are condensed and dropped into the conduit 17, by which they are conducted while still hot to the jet in the charging line or other suitable device for forcing the condensate into the charging stream. The separator is preferably somewhat elevated so as to give a considerable head of liquid in the pipe 17, which preferably contains a U bend, as illustrated, in order to form a liquid seal therein. This head of liquid, together with the high pressure at which the oil in the charging line passes the jet, this pressure being ordinarily from 50 to 100 pounds higher than the pressure in the drum, insures that the condensate shall be constantly and positively drawn into the charging line and forced into the coil 1. The introduction of this hot condensate into the charging line increases the volume of oil in the heating coil and thereby accelerating the flow therein and producing a foamy mixture so that local overheating is prevented and the coil is kept substantially free from any slight carbon formations. This condensate consists in a type of hydrocarbon which when decomposed does not yield any great amount of carbon so that the oil charge is constantly being diluted with oil capable of being decomposed into lighter products without the production of large amounts of carbon. This condensate reaches the jet in a heated condition, preferably at a temperature not materially below its boiling point, so as to heat the charge of oil entering the heating coil. The heat cycle formed by the kerosene constituents contributes to the maintenance of the proper temperatures in the heating coil and the cracking drum. By injecting or otherwise suitably forcing this condensate into the heating coil, I increase the volume of oil flowing therein without increasing the total amount of oil charged into the system at any given time.

A considerable pressure is maintained throughout the system, which pressure is regulated by means of the valve 20 or the valve on the gas outlet 22. The pressure used varies with the character of the oil operated on and the character of the product desired. Ordinarily the decomposition in the cracking drum is carried on under a pressure of from 100 to 400 pounds. In utilizing oils of the type commonly employed for decomposition into products of the nature of gasoline a temperature in the drum 11 of from 700° F. to 850° with a temperature in the coil 1 of from 700° F. to 950° F. is ordinarily used. For example, in cracking a paraffin base gas oil of a Baumé gravity of about 34°, a temperature of 850°

F. in the coil and of 775° F. in the drum with a pressure of approximately 200 pounds has been used to advantage.

The oil to be decomposed is constantly forced into the heating coil thereby causing a steady stream of heated oil to enter the cracking chamber. The residuum is withdrawn preferably at such a rate that there is maintained a constant body of oil in the cracking zone.

It is desirable to equip the apparatus with the valves 10 and 17 so that in case there is a break in the heating coil the effect of any fire resulting may be localized by closing said valves, whereby the bulk of oil in the system will be retained in the cracking drum 11. It is understood that in the normal operation of the process, these valves are open.

Auxiliary heat may be supplied to the cracking drum in any suitable manner if desired, and a convenient method of providing this auxiliary heat is, as shown in Figure 2, to insulate only the upper part of the drum and apply heat at a moderate temperature or in a relatively small quantity from any suitable heater such as is designated 30. In the early stages of a run, since there is no danger of overheating a carbon-free surface, the drum may be heated freely until the necessary heat cycle has been generated and decomposition has begun. For this reason the arrangement of Figure 2 possesses certain advantages over that of Figure 1. But when decomposition begins, with a consequent deposition of carbon, the heat must be reduced, as otherwise the carbon would accumulate on the hot surfaces and build up tenacious formations thereon, thus preventing the effectual removal of the carbon and asphaltic bodies. As the run continues, only a moderate heat is applied, sufficient only to offset the loss of heat due to radiation and distillation. If desired the drum may be heated by means of waste heat from the furnace 2 or in any other suitable manner.

The product obtained by the herein disclosed process is, for a cracked product, remarkably sweet, in other words, low in unsaturated compounds.

It is understood that I use the terms gasoline and kerosene in this application by way of example and that these terms are taken as types of other similar distillates which may be produced by my process. I use the term gasoline as an example of the volatile product desired which under the temperatures and pressures used is a vapor in the separator 15 and is condensable in the cooling coil 18. I use the term kerosene as an example of those constituents which under the temperatures and pressures used is a vapor in the vapor line 13 but is condensable in the separator 15. It is to be noted that the gravity and boiling point of the products which will condense in the separator 15 depends upon the temperature therein under the pressures used.

Although for illustrative purposes the invention has been shown and described in connection with apparatus of more or less specific details of construction, arrangement and location of parts, and as embodying in its mode of operation a certain series and sequence of somewhat definite steps and operating conditions, it will be understood that many of the objects and advantages of the invention may be obtained, to a greater or less extent, through the employment of apparatus of modified character, or, in fact, through variations or, in some cases, omissions, of certain of the component steps, without departing from the spirit and scope of the invention.

What I claim is:

1. The process of converting hydrocarbon oil which comprises forcing said oil through a coil and drum while applying heat to said coil and drum and allowing the vapors generated to develop pressure until decomposition of the hydrocarbon begins, then reducing the heat applied to the drum while securing it against substantial loss of heat through radiation and vaporization, and continuously supplying to the oil in the drum the necessary heat for decomposition by means of the stream of oil entering from the coil, the stream entering the coil being continuously commingled with a hot condensate separated out from the generated vapors.

2. The process of converting hydrocarbon oil which comprises forcing said oil through a coil and drum while applying heat to said coil and drum and allowing the vapors generated to develop pressure until decomposition of the hydrocarbon begins, then reducing the heat applied to the drum while securing it against substantial loss of heat through radiation and vaporization, and continuously supplying to the oil in the drum the necessary heat for decomposition by means of the stream of oil entering from the coil.

3. The process of converting hydrocarbon oil that comprises forcing a stream of oil through an elongated passageway of restricted cross-section and thence into an enlarged chamber while applying heat freely to both said passageway and said chamber to rapidly raise the oil to a cracking temperature and develop a superatmospheric cracking pressure therein and, after said conditions of temperature and pressure have been attained, applying to said enlarged chamber reduced or moderate heat sufficient only to maintain a cracking temperature in said chamber while continuing the free application of heat to said passageway.

4. The process of converting hydrocarbon oil that comprises passing a stream of oil

through an elongated passageway of restricted cross-section, and then delivering it into an enlarged zone where a body of oil is maintained, freely heating the oil in said passageway and in said enlarged zone during the starting period until cracking conditions of temperature and pressure are established, and subsequently continuing the free heating of the oil in said passageway but applying to the body of oil in said enlarged zone a reduced and moderate amount of heat sufficient to offset heat losses and to maintain a cracking temperature therein throughout the period of normal operation.

5. The process of converting hydrocarbon oil that comprises freely heating a moving stream of oil in its passage through a heating coil and distillation drum during the starting period to rapidly establish cracking conditions of temperature and pressure therein, then continuing the maintenance of said conditions during the period of normal cracking operations by heating the oil in said drum at a reduced and moderate rate while continuing to freely heat the oil in the coil, removing the vapors from the distillation drum, and separating out and returning to the heating coil the condensed heavier fractions thereof.

In witness whereof I have hereunto set my hand and seal this 8th day of June 1927.

OTTO BEHIMER.

UNITED STATES PATENT OFFICE

RUFUS S. MERRILL, OF CAMBRIDGE, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO WM. B. MERRILL, JOSHUA MERRILL, AND RUFUS S. MERRILL.

IMPROVEMENT IN HEAVY HYDROCARBON OILS FOR ILLUMINATION.

Specification forming part of Letters Patent No. 100,915, dated March 15, 1870; reissue No. 7,096, dated May 2, 1876; application filed March 8, 1876.

DIVISION B.

To all whom it may concern:

Be it known that I, RUFUS S. MERRILL, of Cambridge, in the county of Middlesex and State of Massachusetts, have invented a certain new and useful product obtained from the distillation of coal, shale, and petroleum, and having a very high igniting and fixed distilling-point, being an oil which, possessing properties of great value and importance as a cheap, safe, and brilliant illumination material, constitutes a new commodity or article of manufacture and trade heretofore unknown, and not sold or used as such.

In the specification annexed—reissue, Division A, of my Letters Patent No. 100,915, dated March 15, 1870—I have described a method of burning such oils for illuminating purposes, an invention or discovery which led me to experiment upon methods to produce on a manufacturing scale—that is to say, with a degree of certainty and economy—an oil possessing the qualities before indicated, which may have and has been produced in the manufacture of other products of distillation incidentally or accidentally, without any known rule or method therefor, and which were useless, and the production of which was therefore avoided as much as possible.

In order to fully understand the nature of my invention, it will be necessary for me to describe the processes usually practiced in the manufacture of petroleum and such like hydrocarbon oils, and to show wherein my present invention differs from them.

The process may be divided into two classes, As follows: First, the distillation known as the "cracking process," when the object is to make from the crude oil the largest possible percentage of kerosene or ordinary refined petroleum oil; second, the process known as "true fractional distillation," when the object to be attained is the production of oils of differing characteristics and uses, such as naphthas, kerosene-oil, paraffine or lubricating oils, and paraffine-wax.

In practicing the process first mentioned, the crude oil is placed in a suitable distilling-vessel provided with a suitable condensing apparatus, and when the manhole-plates are properly secured a fire or fires are started under the still. The oil when sufficiently heated begins to vaporize. The vapors arriving in the still pass over through the condenser, and are condensed again into liquid. The first to pass over is naphtha of very light gravity, and is very volatile. This is allowed to run into suitable tanks, until the gravity reaches about 60° Baumé at 60° Fahrenheit. At this point the stream from the condenser is changed into another tank, and the distillation continued so long as the oil runs comparatively white in color, and of a gravity of about from 42° to 43° Baumé. At this point the oil begins to grow yellow in color, and feels slightly oily between the thumb and finger, and it is at this stage of the distillation that the "cracking process," so called, begins. The fires are reduced under the still by damping, and the stream of oil flowing from the condenser is greatly lessened, the process being so conducted that the heavy oil remaining in the still is lifted in vapors, and again condensed in the still, and falls back, to be again and again vaporized and condensed, the lighter vapors, which are formed by this process, alone passing over to the condenser and out at the outlet. These lighter vapors when condensed form an oil of much the same general characteristics as that already distilled over for burning oil, being of light gravity of about 45° or 46° Baumé, comparatively white in color, thin in body, and mobile like kerosene-oil. This process is continued until only from five to eight per cent. of the crude oil placed in the still is left in the form of a black residuum, which, when sufficiently cooled after removing the fires from under the still, is drawn off and usually again distilled, to be manufactured into paraffine-oils, and sometimes the paraffine-distillates are again returned to the crude oil, to again go through the cracking process, until eventually it is all cracked up into thin and low fire-test, or ordinary kerosene-oil, or refined petroleum.

The second process referred to, known as the fractional distilling process, is directly the reverse of the one just described, and is designed to separate petroleum into its various products of naphtha, kerosene, paraffine, lubricating-oils, and paraffine-wax. In working by this process the crude oil is placed in a suitable distilling apparatus, to which a condensing coil or pipes are secured, the same practically as is used in the process first described. Crude oil is placed in the still, usually filling it two-thirds to three-quarters full, and a fire started under the bottom of the still, and the oil heated until vapor arises and passes over to the condenser, when, coming in contact with cold surfaces, the condenser being immersed in cold water, which is constantly renewed from a supply-tank, the vapor is condensed and flows out a liquid. The first to pass over is, as in the cracking process, naphtha. This is allowed to run into a suitable tank until the gravity reaches about 60° Baumé hydrometer. The fire being continued under the still, the distillation goes on as at first described, and the stream of oil being at this gravity conducted into another tank for kerosene oil the distillation goes on precisely the same as in the process first described until the burning or kerosene oil portion is all distilled over, which is known by the oil growing slightly yellow in color and heavy in gravity. The kerosene or burning oil usually embraces the portion distilling over between 60° and 42° to 43° Baumé, and from sixty to seventy per cent. of the crude oil placed in the still is distilled over in the form of naphtha and burning or kerosene oil. Up to this stage of the distillation the processes have been conducted precisely alike; but now the essential difference of the fractional distillation from the cracking process begins. Instead of now reducing the fires under the still, and so conducting the process of distilling that the cracking of the heavier oils left in the still will be the result, the fire is somewhat increased, and the distillation goes on rapidly. The stream of oil from the condenser is conducted into a suitable tank until about 38° to 36° Baumé is reached. This oil coming over from 42° to 36° Baumé I call "intermediate oil," which is too heavy and fixed for kerosene or the ordinary refined petroleum-oil, and too light and thin for lubricating-oil. To this I shall refer further on, as the product I produce from it constitutes the invention I have made. After the gravity reaches from 36° to 38° Baumé, the stream of oil is again changed into a suitable tank, and distillation carried on in as rapid a manner as possible to prevent cracking of the oil, and it is continued until the oil is all distilled over, or until a small quantity of residuum is left in the still. The last-named oil—that is to say, the oil that passes over between from 36° to 38° Baumé, and the final finishing of the distillation—is paraffine-oil, heavy in body and gravity, containing abundance of paraffine, which, by suitable or well-known process, is made into the paraffine lubricating-oil of commerce. I now refer to the intermediate oil alluded to before. This oil usually comprises that portion of the fractional distillation of hydrocarbon oils between 42° and 36° Baumé.

It has been the custom of manufacturers of oil to subject this oil to the cracking process, in order to make it into thin illuminating-oil, like kerosene. It is also frequently put back into crude oil, and with the whole mass of oil subjected to the cracking process, and thus allowed to mix with the products of distillation of the crude oil. By these processes it is gotten rid of and utilized. It must be borne in mind that when this intermediate oil is mixed with kerosene without the process of cracking it into thin oils being applied to it, it greatly injures the kerosene, causing it to change in color, to burn badly in lamps, i. e., crusting the wicks and causing the flames to fail when the oil is only slightly reduced in the lamp. Although it has, in past years, been somewhat resorted to to mix it with the kerosene, it is not so practiced at the present time, but it is subjected to the cracking process either alone or mixed with crude oil, and so worked until it is finally all cracked up and lost sight of in the mass of oil produced. Attempts have been made to utilize this oil by mixing it with the heavy paraffine oil, before alluded to, and naphtha, and by subjecting the mixture to distillation; but an inferior and dangerous oil has been the result of this mixing and distilling process.

The heavy oil passing over under the influence of the higher temperatures, is, however, variable in its nature as to density and fire-tests. From oils having the desired fire-test of 200° Fahrenheit, oils of higher, and for illuminating purposes impracticable, points of ignition are reached. On the whole the quantity of heavy oil which answers the condition of my invention is so small that it would be impracticable to collect it for the purposes of commerce and trade.

To obtain this oil in any desired quantity and of a permanent character as to the requisite fire-test, I proceed as follows: I take the intermediate oil, so-called, which is really a combination or mixture of heavy oils of various densities and boiling-points, and redistil it at a comparatively low temperature. The vapors are passed through a condenser and liquefied.

The intermediate oil may thus be almost entirely converted into heavy oils of the desired consistency and fire-test. Only a comparatively small quantity of very heavy oil will remain in the still, which may be used as, or made into, an excellent lubricating oil by processes it is unnecessary here to describe.

The oil thus produced burns with great beauty and brilliancy, with a white and highly-illuminating flame when burned in suitably-constructed lamps; and the oil so produced has the following new and valuable qualities

that render it of great practical value in the art as a new manufacture and commerce not heretofore known or used: First, it has a very high distilling-point; second, it has a very high igniting-point, and will not give off inflammable vapors at any temperature below 200° Fahrenheit; third, it is perfectly safe for illuminating purposes for lighting railroad-cars, factories, steam-ships, and for other domestic uses; it is safe to transport and store; fourth, it gives a beautiful white light when burned in suitably-constructed lamps; fifth, it is cheap and burns economically. In actual practice, a lamp giving the light of twelve sperm candles can be maintained at a cost of less than one cent per hour.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

As an article of manufacture an illuminating-oil derived from petroleum, coal, shale, and schist, emitting no inflammable vapor at a temperature of less than 200° Fahrenheit, as herein set forth.

In testimony whereof I have hereunto signed my name this 6th day of March, A. D. 1876.

RUFUS S. MERRILL.

Witnesses:
JOSIAH DAVIDSON,
MARK HOLLINGSWORTH.

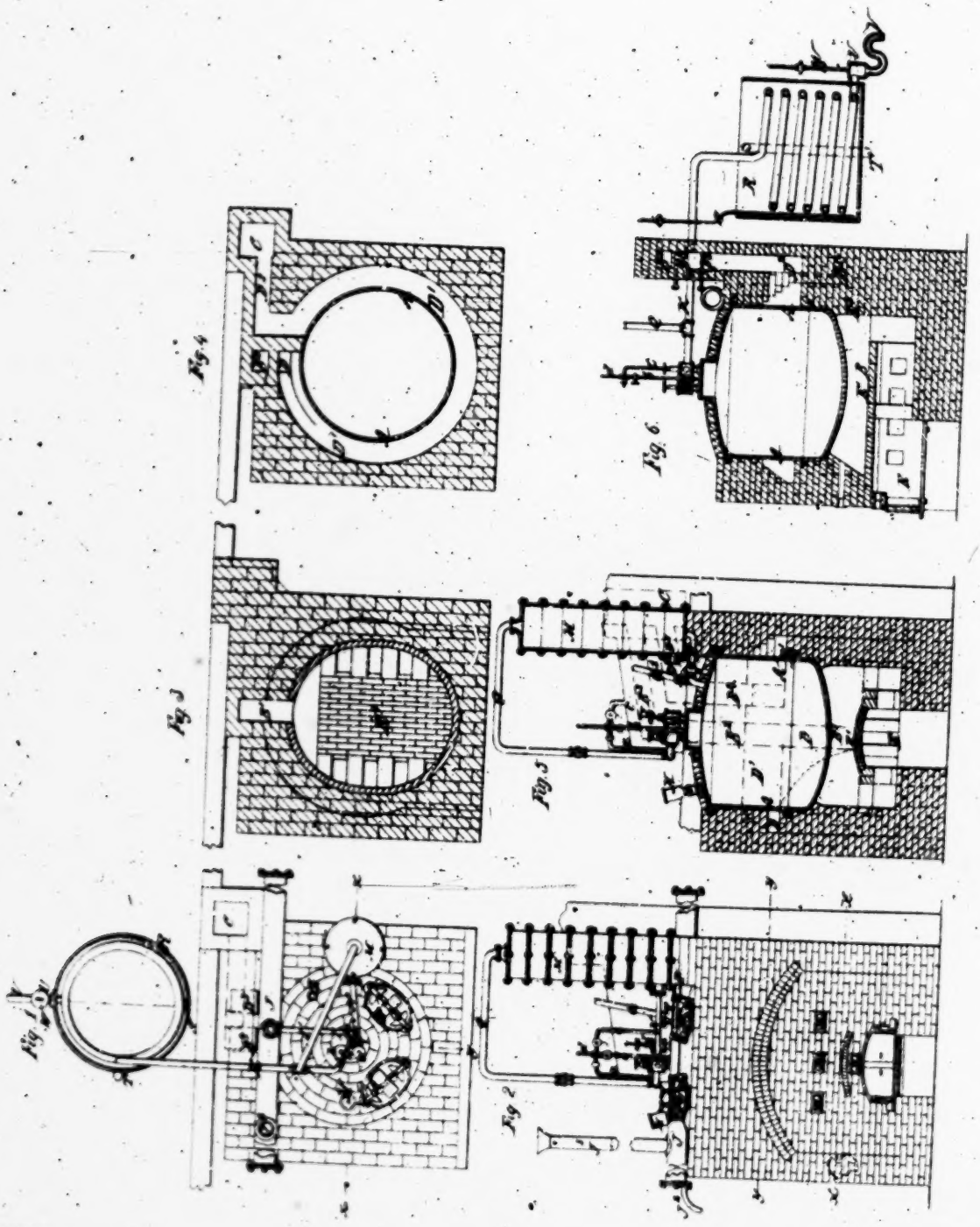
3110

L. ATWOOD.

Oil Still.

No. 28,448.

Patented May 29, 1860.



Witnesses:

Inventor.

UNITED STATES PATENT OFFICE.

LUTHER ATWOOD, OF NEW YORK, N. Y.

IMPROVEMENT IN THE MANUFACTURE OF OILS OBTAINED FROM COAL.

Specification forming part of Letters Patent No. **28,448**, dated May 29, 1860.

To all whom it may concern:

Be it known that I, LUTHER ATWOOD, of the city and county of New York, and State of New York, have invented certain new and useful Improvements in the Manufacture of Hydrocarbon Illuminating Oils; and I do hereby declare that the following is a full and exact description thereof, reference being had to the annexed drawings, making a part of this specification, and to the letters of reference thereon.

Thin hydrocarbon oils suitable for illuminating purposes, and such as are now burned in the "Deitz," and similar chimney lamps, are usually obtained from petroleums or natural oils, and crude oils obtained by distilling at comparatively low temperatures bituminous coals, bituminous shales, bituminous schists, peat asphaltums, rosin, and the tarry or pitchy residue remaining in the process of manufacturing adamantine or stearine candles. These natural oils and the crude oils, distillates of the above-mentioned and similar substances, it has heretofore been the practice to distill over in a cast-iron still suitable for such purposes, and to separate and set aside the first or lighter portion of the distillate, or such portion as comes over until the temperature in the still rises to about 600° Fahrenheit, for the purpose of manufacturing into illuminating oil, with the exception, sometimes, of such exceedingly volatile part as can be steamed off during the process of manufacture. The latter portion of the distillate, which comes over at an increased temperature, is termed "heavy oil." It generally contains visible crystals of paraffine, and has heretofore been generally manufactured into lubricating oils and candles. By repeated simple distillations of the heavy oil a further quantity of thin oil has been obtained, the heavy oil remaining containing larger proportionate quantities of paraffine. I mention this in order that it may not be confounded with my process.

My said invention consists in a method of treating these heavy oils, paraffine, fatty oils and acids, or the crude oils and natural oils from which the heavy oils are produced, as above mentioned, so that the whole or as much as desired may be converted into thin oil suitable, when purified, to burn in lamps.

My process is a practical development, embodiment, and combination of two operations peculiar to these bodies in a process of continuous distillation—viz: first, a gradual and continuous application of sufficient heat to the substance acted on to initiate chemical changes which result in the decomposition or breaking up of the heavy bodies and the formation of light and heavy oil-vapors, and comparatively small amount of fixed gases accompanied with deposition of carbon in the still; second, a continuous separation of the light thin oil-vapors and fixed gases from the heavier oil-vapors, and continuous condensation and return of the latter to the sphere of action of the heat until the whole is broken up, or nearly so, or as much as desired, by exposing the eliminated vapors in a chamber or receiver of considerable capacity situate between the point of forming the vapor and the condenser to a temperature about the boiling-point of the lighter vapors and below the boiling-point of the heavier vapors, so that the heavy vapors gradually liquefy and return to be broken up by further action of the heat, while the desired light product passes over to the condenser, where it is liquefied and separated from the fixed gases.

It will be observed that, owing to the fact of the return to the action of the heat of the heavy oil when it is nearly at the boiling-point, a comparatively small increase of temperature is necessary to break it up. This gives my process a great economical advantage over the former practice of successive plain redistillations, by which a further portion of thin oil has heretofore been obtained from heavy oils, as described in the beginning of this specification.

The apparatus I prefer to use is figured in the annexed drawings, of which Figure No. 1 is a plan view; Fig. No. 2, a front elevation; Fig. No. 3, horizontal section through dotted line *x x*, Fig. No. 2; Fig. No. 4, horizontal section through dotted line *y y*, Fig. No. 2; Fig. No. 5, transverse section through dotted line *x x*, Fig. No. 1; Fig. No. 6, vertical longitudinal section through dotted line *y y*, Fig. No. 1.

Letter A represents a cast-iron still constructed with a removable lower section for the purpose of convenient repair. The bottom of the still is heated by products of com-

bustion supplied to the chamber B from the fire-box E, the arch E', with its piers and passages, serving to divide and distribute the products of combustion equably within the chamber B.

B' is a short horizontal passage connecting the chamber B with the flue B², which is furnished with a damper, B³, and connects with the chimney C.

D is an uptake opening out of the passage B and leading up to the flue D', which, passing around the sides of the still, connects with the chimney C by the passage D², which is furnished with a damper, D³. When the damper B³ is closed and the damper D³ open, the products of combustion from the chamber B are forced to pass through the flue D', heating the sides of the still on their way to the chimney. I use the flue D' in this manner in commencing a distillation. After the distillation has commenced, I shut the damper D³ and open the damper B³ in the passage B', which connects the chamber B directly with the chimney.

Letters F F are two man-holes for removal of residue, provided with the covers and fastenings.

Letter G is a filling-pipe provided with a stop-cock, (shown broken off,) but must be connected with a reservoir of unfinished oil.

Letter H is a funnel-pipe provided with a stop-cock, used also for filling the still.

Letter I is a weighted safety-valve on the dome of the still, through which vapors can escape when, from any cause, the worm becomes choked. The stem of the valve is fitted to receive a slotted weight, and terminates in a ring-handle, by which it may be raised up and hooked on the hook I' when necessary to keep the passage open.

Letter J is a main or condensing pipe, connected with the safety-valve by the blow-off pipe J'. The condensable products escaping through the safety-valve and saved in the main J flow out through the small pipe J' into any suitable receiver, the fixed gases and vapors not condensed escaping through the discharge-pipe J³, (shown broken off,) but to be carried up through the roof of the building, or in any suitable manner away from the vicinity of the still.

Letter K is a pipe connecting the worm-condenser with the still through the angle-valve L.

Letter M represents a vertical cast iron chamber of cylindrical form, standing on the top of the brick-work casing of the still and near the still. This chamber I call a "separating" chamber. It connects with the still by the superior pipe N through the angle-valve O, also by the inferior pipe P, which is furnished with a stop-cock. The pipe Q, provided with a stop-cock, connects the top part of the separating-chamber with the worm-condenser through the pipe K. The separator is made in sections connected by flanges and screw-bolts for the purpose of conveniently increasing or diminishing its capacity. The worm-condenser is situated in a water-tub, R, supplied with cool water from a force-pump or a reservoir, by the inflow-pipe S, the surplus flowing out through the pipe T. The worm terminates in a small chamber, U, from the bottom of which the liquid products escape through the sealed siphon-pipe V, the fixed gases passing up through the gas-pipe W, (shown broken off,) but to be carried up through the roof or away from the vicinity of the still. The gas-pipe W is furnished with a stop-cock, to be closed when necessary, to blow steam through the chamber U and siphon V for the purpose of removing obstructions or to cleanse them.

Letters *a*, *b*, and *c* are steam-pipes, each provided with a suitable valve or stop-cock, connecting, respectively, with the dome of the still, the pipe K, and the pipe N, and by a branch coupling with a steam-pipe, *d*, (shown broken off,) but which must be connected with a steam-boiler.

Letter *e* is a draw-cock used for the purpose of discharging condensed steam from the steam-pipe.

The steam-pipe *a* is used in combination with the safety-valve outlet when open, the other openings in the still being closed for the purpose of expelling by pressure of steam the vapors and gases remaining in the still at the completion of a distillation, and also after removal of the residue, to prepare the still, when hot, for the safe reception of a charge of oil by forcing steam into the still in sufficient quantity to displace atmospheric air, as described in other Letters Patent of the United States to me.

When the angle-valve L is shut and the stop-cock in the pipe Q, which connects the separating-chamber with the pipe K, is closed, steam may be blown through the worm-condenser from the steam-pipe *b*, for the purpose of removing obstructions and cleansing the condenser. When the angle-valve O is shut and the stop-cock closed in pipe P and the pipe Q open, steam may be blown through the separating-chamber and condenser from the steam-pipe C.

For the purpose of the process herein described, the direct connection from the still to the worm-condenser through the angle-valve L is kept closed, to be opened when desirable to interrupt the process of obtaining light thin oil from heavy oil, and to run over heavy oil. In that case the connections to and from the separating-chamber are to be closed.

The operation of my process is as follows. The apparatus having been arranged for the operation as above described, I place the substance to be acted on in the still and gradually and continuously apply sufficient heat externally to initiate chemical changes, which results in breaking up or decomposing the substance acted on, forming light and heavy oil vapors, with comparatively small quantity of permanent gases, and with accompanying de-

position of carbon in the still. The vapors and gases pass through the superior pipe N upward into the separating-chamber M. The separating-chamber being exposed externally to the cooling influence of the atmosphere of the still-room, and heated only by the radiated heat from the top of the still and the incoming vapors and gases, a temperature comparatively higher or lower in proportion to the relative quantity of incoming vapor, but sufficiently below the boiling-point of the major portion of the heavier or higher boiling-point vapors to gradually liquefy them is maintained internally, and as they liquefy and fall to the bottom of the separating-chamber they are continuously returned to the still through the inferior pipe P. The lighter vapors and permanent gases gradually rise to the top of the separator and pass on through the pipe Q to the worm-condenser, the liquid products passing out at Y, the gases escaping upward through the pipe W.

From the above description it will be evident to those skilled in the art that the particular character of the distillate will depend on the degree of rapidity with which the operation is conducted within such limits as it can be carried on at all in the above-described apparatus. If vapors are not formed with sufficient rapidity and in sufficient quantity to keep the internal temperature of the separator up to a point about the boiling-point of the lighter vapors, they will, of course, all condense and fall back in the still. If heat is applied so actively as to form vapors rapidly enough to keep the temperature nearly up to about the boiling-point of the heavy vapors, a portion of them will be forced over and condensed with the lighter vapors. Therefore the particular degree of change resulting from any one operation will be governed by the relative quantity and degree of heat applied.

It is not material in the practical working of my process to effect the desired change in one operation, neither is it generally convenient or practical to do so; but within the limits above mentioned the slower the operation is conducted the greater will be the change effected by one distillation.

During the necessary and commonly practiced processes of purifying hydrocarbon illuminating oils by treating them repeatedly with acids and caustic alkalies, they are subjected to redistillation, which may be performed by my process, and the operation of converting heavy oil into light oil go on with the purification process, with which it does not interfere.

When carrying on my process in this manner, after the purification is completed I prefer to distill over such portion of the purified oil as will go over at below about 600° Fahrenheit, with the still arranged so as to have direct communication with the condenser through the angle-valve L, and with the separating-chamber cut off. This portion is then fit for use. The remaining contents of the still are then run over through the separator, and, for reasons not necessary to mention here, being obvious to those skilled in the art, subjected to further treatment.

When crude oil is subjected directly to my process the light portion, generated simultaneously with the heavy bodies in the original production of the crude oil by distilling coal or other substances, passes over until the temperature of the still rises above about 600° Fahrenheit, when my process of breaking up the heavy bodies commences. The relative height of the separating-chamber is an important element in its proportion, because it favors separation of the vapor by difference of specific gravity.

The proportion, situation, and arrangement of the separating-chamber as figured in the drawings I consider best for a still such as shown with a body or boiler of about seven feet in diameter. In a still of such dimensions I carry on the operation at the rate of ten gallons per hour.

Although I prefer the apparatus herein described and figured, and consider it best adapted to carry on my process rapidly and profitably, I will nevertheless use any form of apparatus or still in which I can practically carry on my process.

The illuminating oils resulting from my process, when purified and finished as usual with illuminating oils heretofore manufactured from the lighter parts of the crude oils, do not differ materially from them in color or mobility; but owing, perhaps, to the greater proportionate quantity of paraffine in the source from which they are immediately derived, they possess greater illuminating power. In the practical manufacture of these oils they may be beneficially mixed with other light oils; or when operating on crude oil the distillate of both light and heavy parts may be suffered to run into the same cistern or other receiver.

By the use of my process above described the manufacturer can, by a comparatively small number of distillations, break up or convert the whole heavy liquid and solid portions of the crude oil into light thin illuminating oil whenever it is desirable to do so.

What I claim as my invention and improvement in the manufacture of hydrocarbon illuminating oils is—

The production of thin oils suitable to be manufactured into illuminating oils from the heavier parts of the crude and fixed oils and other substances within mentioned by treating them in manner substantially as hereinbefore described during one or several continuous distillations.

LUTHER ATWOOD.

Witnesses:

BRAIND. G. LATIMER,
F. C. TREADWELL, JR.

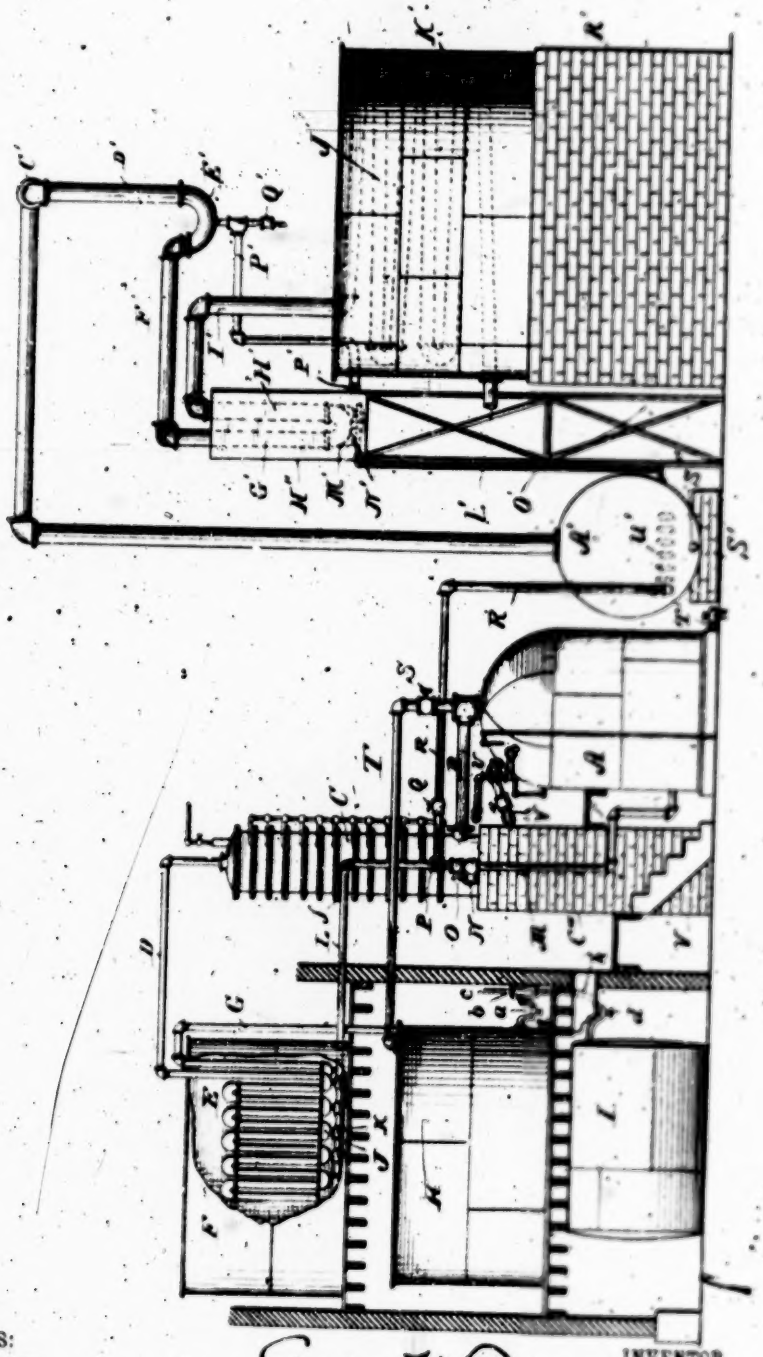
3116

(No Model.)

G. H. PERKINS.

PROCESS OF DISTILLING PETROLEUM.

No. 399,073. Patented Mar. 5, 1889.



WITNESSES:

John Jolley Jr.

F. Norman Dixon.

INVENTOR

George H. Perkins,

By his Attorneys,

W. C. Strawbridge &

J. Bonsall Taylor.

UNITED STATES PATENT OFFICE. 3117

GEORGE H. PERKINS, OF PHILADELPHIA, PENNSYLVANIA.

PROCESS OF DISTILLING PETROLEUM.

SPECIFICATION forming part of Letters Patent No. 399,073, dated March 5, 1889.

Application filed May 14, 1886. Serial No. 202,148. (No model.)

To all whom it may concern:

Be it known that I, GEORGE H. PERKINS, a citizen of the United States, residing in the city and county of Philadelphia, and State of Pennsylvania, have invented a new and useful Process of Distilling Petroleum, of which the following is a specification.

Generally stated the process of distillation of petroleum oil, as heretofore practiced, has consisted essentially in submitting the product to be distilled, in a vessel or still, to heat, whereby the oil has been vaporized, the vapors having been conveyed by suitable pipes through condensing chambers or worms, externally cooled, with the result that the lighter products have been condensed in the condensing devices and therefrom conveyed to proper storage receptacles, the heavier products having been condensed in the condensing devices and therefrom returned by suitable pipes to the still for redistillation. In the process of distillation just referred to the quantity of the lighter products of distillation obtained in the condensing apparatus employed has been too small as compared with the resulting heavier products, which, as above stated, had, during the process, to be returned to the still for further treatment. Moreover, in said process, the return of said heavier products of distillation from the condensing apparatus to the still resulted in the admixture therewith of the impure residual matters remaining in the still and the consequent deterioration of the product obtained by the redistillation of said heavier products.

Generally stated, my invention consists in treating a petroleum product with heat in a still, in passing the resulting vapors through a suitable condenser, in conveying by suitable conduits, the lighter distillates to a proper receiving vessel, and in conveying the heavier distillates, which have not been trapped back into the original still, to a supplementary vessel or still in which they may, without other heat than that originally derived from the original still, further separate into heavier and lighter products.

A convenient form or embodiment of my invention is represented in the drawing, and is hereinafter described and claimed.

The drawing is a side elevational and sectional view of my apparatus, the construction of which will be understood from a description of its mode of operation.

A is a still which, at its bottom, is provided with a steam-coil. Into this still is charged the petroleum product which is to be distilled and separated into distillates of different gravities. The vapors from this still pass through the pipe B to the column C which is provided with successive cooling chambers, of any well known construction, and thence through the pipe D to and through the goose worm E located in the water-supplied condenser F, and thence through the return pipe G to and through a goose worm located in the water-provided condenser H. From the condenser H the condensed lighter distillates are conveyed through the traps *g* and *h* to a receiving vessel I, said traps being provided with cocks *a* and *d* to permit of samples of distillate being, at these points, run off for examination.

The trap *g* is provided with a glass reservoir *b* to permit the flowing distillate to be seen, said reservoir being provided with a gas vent pipe *c* for the escape of such gases as may be carried forward with the condensed distillate. Such heavy distillates as are condensed in the column C are conveyed therefrom, at the point N, through the pipe M back to the still A for redistillation. Up to this point of the operation the valve O in the pipe P has been open. When the lighter distillates begin to flow into the reservoir I the valve O is closed and such heavy distillates as have condensed, or such as shall during the remaining part of the process condense, in the bottom of the return bends of the goose worm E, are, by the pipe L, and the pipe R, conveyed to a capacious supplementary still or separating chamber A', which may be of any suitable construction and of which the capacity should be at least as great as that of the original still A. These condensed products are fed to the still A' at a point near the bottom thereof, and under the surface of a bath of benzine, or other petroleum product, which has previously been charged into the still A' and by means of a steam-coil C' heated up to a temperature corresponding to the temperature of the condensed distillate charged

into the tank A' from the bottom of the return bends of the goose worm E. So soon as the trapped back material from the goose worm E commences to flow into the supplementary still A' the steam is turned off from the coil U' and is kept turned off so long as the trapped back material continues to flow into said supplementary still. At this point of the operation the lighter distillates from the still A are being received in the vessel I, and the heavier products condensed in the column C are being returned to the still A for redistillation. At this point also the heavier products condensed in the goose worm E are being conveyed to the supplementary still A', where they are, by reason of the enlarged space therein afforded, caused to more perfectly separate into vapors of different gravities. These vapors are thence, by the pipes B' C' D' and F', conveyed to and through the goose worm G' H' contained in the water-provided condenser H'', and thence through the pipe I', to and through the goose worm J' located within a water-provided condenser K', with the result that the heavier distillates are condensed in the trap E' and in the bottom of the return bends M' of the goose worms G' H' and are therefrom, by the pipes P' N' and O' returned to the still A' for redistillation. The lighter vapors from the supplementary still A', which are condensed in the goose worm J', are conveyed by the pipe L' to a proper receiving vessel.

R' and S' are brick work upon which the condenser K' and supplementary still A' are respectively supported. The apparatus is operated in the manner just described so long as the lighter distillate hereinbefore referred to is being received in the receptacle I from the still A. When this product ceases to be produced by the still A the valve Q is closed and the valve O is opened, whereby the heavy distillates condensed both in the column C and in the bottom of the return bends of the goose worm E are trapped back into the still A. At this point the supply of heavy distillate to the supplementary still A' ceases. Steam is now supplied to the steam coil U' to maintain the temperature of the trapped back product remaining therein, and to effect the further separation of said residual product. The application of heat to the supplementary still A' is continued so long as the distillate escaping at L' remains of the same gravity as the distillate which has during previous part of the process escaped therefrom. So soon as the distillates received from the pipe L' and from the cock *a* are of gravities lower than is desired the steam is turned off from the coil U', and from the coil in the bottom of the still A, and the heavy residual products in said stills A and A' are drawn off through the pipes S'' and D', the still A is again charged, and the operation hereinbefore described repeated.

U and V are pipes through which respectively the still A is charged, and the steam coil therein fed.

T is a pipe leading from the still A to the condenser H. This pipe may, by opening the valve S, be employed, at or near the end of the distillation in the still A, to conduct the last distillates from said still directly to the condensing worms in said condenser.

Heretofore it has been usual in the distillation of the products of petroleum to employ apparatus in which the heavy distillates in the worm E were returned to the still A, for redistillation, through the pipe L connecting with the bottom of the return bends of said goose worm E and emptying into the column C at a point *f*.

By my invention, I am enabled, by reason of the provision of a capacious supplementary still or separating chamber, to effect a quiet natural and more perfect separation of the gases of different gravities, and to avoid the return of the heavy distillates, condensed in the goose worm E, to the original still, and the consequent saturation of said condensed heavy distillates with the impurities remaining in said still, with the result that the quantity of the lighter distillates produced from a given amount of petroleum product is thereby increased and the quality of said product much improved.

Having thus described my invention, I claim—

1. The process of distilling a petroleum product and separating its distillates, which consists, in treating said product with heat in a still, in passing the resulting vapors through a suitable condenser, in conveying, by suitable conduits, the lighter distillates to a proper receiving vessel, and in conveying the heavier distillates, which have not been trapped back into the original still, to a supplementary vessel or still in which they may, without other heat than that originally derived from the original still, further separate into heavier and lighter products, as specified.

2. The process of distilling a petroleum product and separating its distillates, which consists, in treating said product with heat in a still, in passing the resulting vapors through a suitable condenser, in conveying, by suitable conduits, the lighter distillates to a proper receiving vessel, in conveying the heavier distillates, which have not been trapped back into the original still, to a supplementary vessel or still in which they may, without other heat than that originally derived from the original still, further separate into heavier and lighter distillates, and, finally, in distilling and separating the residual products remaining in said supplementary still, by the application of heat thereto, as specified.

3. The process of distilling a petroleum product and separating its distillates, which consists, in treating said product with heat in a still, in passing the resulting vapors through a suitable condenser, in conveying, by suit-

able conduits, the lighter distillates to a proper receiving vessel, in conveying the heavier distillates, which have not been trapped back into the original still, to a supplementary vessel or still in which they may, without other heat than that originally derived from the original still, further separate into heavier and lighter distillates, and, finally, in distilling and separating the residual products remaining in said supplementary still by the application of heat thereto, in conveying the resulting vapors from said supplementary still to and through a proper condenser, in conveying, by suitable conduits, the resulting lighter distillates to a proper receiving vessel, and in conveying the resulting heavier distillates back to the supplementary still, as specified.

In testimony whereof I have hereunto signed my name this 14th day of April, A. D. 1886.

GEORGE H. PERKINS.

In presence of—

WM. C. STRAWBRIDGE,

J. BONSALL TAYLOR.

3122

(No Model.)

J. DEWAR & B. REDWOOD.

PROCESS OF DISTILLING MINERAL OILS AND LIKE PRODUCTS.

No. 419,931. Patented Jan. 21, 1890.

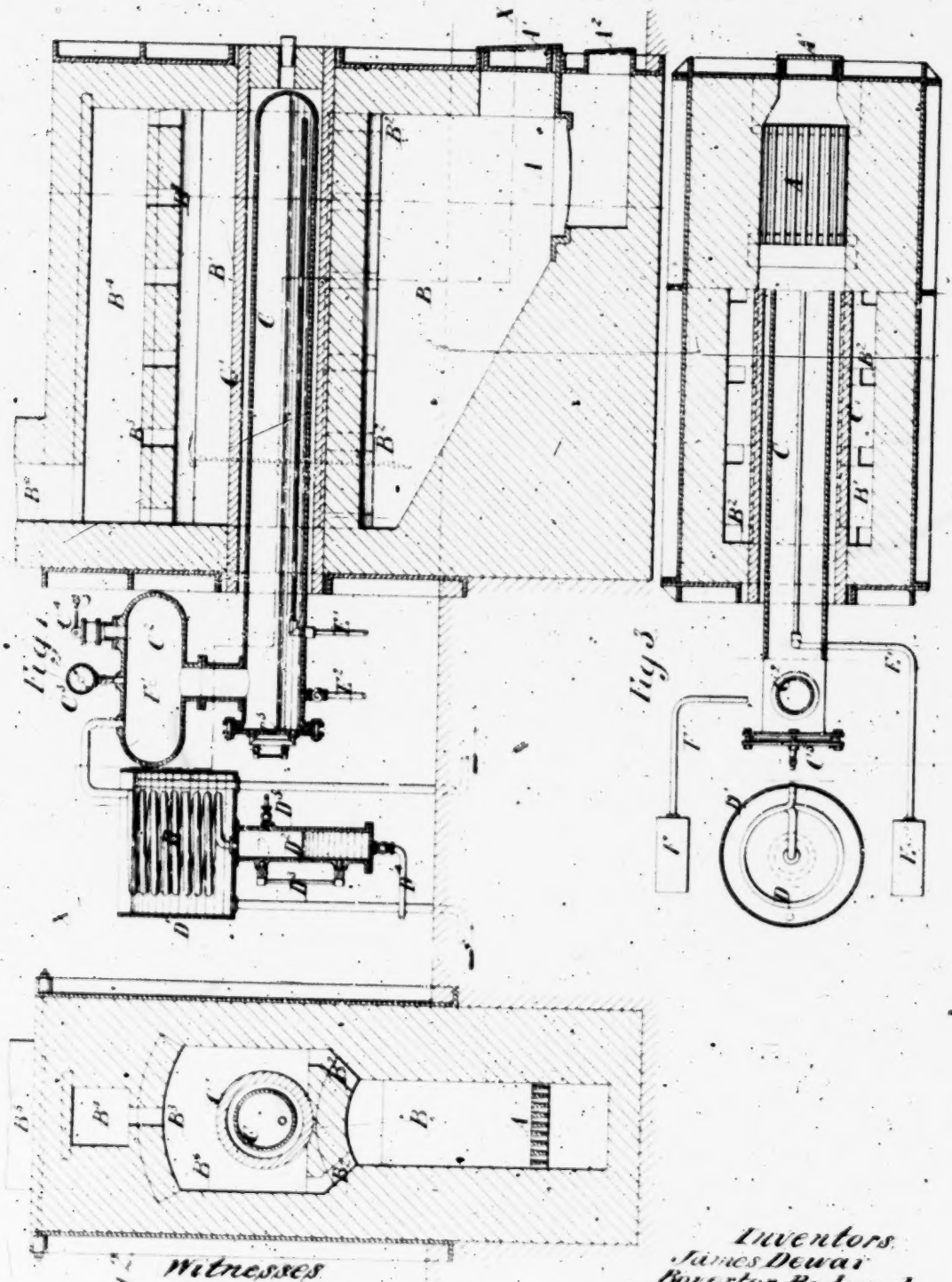


Fig 1

Fig 3

Fig 2

Witnesses
Geo. H. Graves
Chas. Gault

Inventors
James Dewar
Boverton Redwood
By James L. Norris.
Atty.

UNITED STATES PATENT OFFICE.

JAMES DEWAR, OF CAMBRIDGE, COUNTY OF CAMBRIDGE, AND BOVERTON REDWOOD, OF FINCHLEY, COUNTY OF MIDDLESEX, ENGLAND.

PROCESS OF DISTILLING MINERAL OILS AND LIKE PRODUCTS.

SPECIFICATION forming part of Letters Patent No. 419,931, dated January 21, 1890.

Application filed September 3, 1889. Serial No. 322,856. (No specimens.) Patented in England June 24, 1889, No. 10,277; in France August 30, 1889, No. 200,495; in Belgium August 30, 1889, No. 87,570; in Switzerland August 30, 1889, No. 1,339, and in Italy October 1, 1889, LI, 233.

To all whom it may concern:

Be it known that we, JAMES DEWAR, professor of chemistry, and BOVERTON REDWOOD, analytical chemist, citizens of England, residing, respectively, at No. 1 Scroop Terrace, Cambridge, in the county of Cambridge, and at Ballard's Lane, Finchley, in the county of Middlesex, England, have invented new and useful Improvements in the Distillation of Mineral Oils and Like Products, (for which we have obtained Letters Patent in France, dated August 30, 1889, No. 200,495; Belgium, dated August 30, 1889, No. 87,570; Switzerland, dated August 30, 1889, No. 1,339; Italy, dated October 1, 1889, Vol. LI, No. 233, and Great Britain by an application for patent, which patent when granted will bear date June 24, 1889, No. 10,277,) of which the following is a specification.

In distilling mineral oils—such as natural petroleum or similar oil made from shale, coal, or other bituminous substances—in order to separate the lighter oils, suitable for lamps and other purposes, from the heavier oils, there is frequently a very large residue of heavy oil. Attempts have been made to obtain lighter oils from such residues or from heavy natural petroleums by causing the vapor generated in the still-boiler to pass a heavily-loaded valve, so that the vaporization takes place under considerable pressure. It has also been proposed to arrange the still-boiler with its upper part cooled, so that the best volatile portions of the vapor may become more or less condensed and fall back into the hot liquid below, this mode of operating being commonly termed "cracking." Both these methods are objectionable, the former on account of the irregularity of the distillation and the latter on account of the waste of heat in conducting the cracking process and the slowness and insufficiency of the results.

Our invention relates to a method of conducting the distillation by suitable apparatus in such a manner that we get the benefit of regular vaporization and condensation under high pressure, and that we may at the same time get such advantage as can be obtained from cracking. For this purpose we arrange a suitable boiler or retort and a condenser in free communication with one another without interposing any valve between them; but we provide a regulated outlet for condensed liquid from the condenser. We charge and keep charged the space in the boiler or retort and condenser that is not occupied by liquid with gas under considerable pressure, it may be with air or it may be with carbonic-acid gas or other gas that cannot act chemically on the matter treated. The distillation and condensation being thus conducted under considerable pressure, which can be regulated at will, we obtain from the heavy residue a quantity of more or less light oil suitable for illuminating and other purposes, which cannot be obtained by distillation under atmospheric pressure. We may also arrange the still-head or upper part of the boiler or retort so as to operate according to the cracking method above referred to, the cracking in this case taking place under high pressure instead of being carried on under atmospheric pressure.

The apparatus for effecting distillation in the manner described may be arranged in various ways. The accompanying drawings show one form of apparatus for this purpose, which is the subject-matter of a patent application of even date herewith, Serial No. 322,857.

Figure 1 is a longitudinal and Fig. 2 is a transverse section. Fig. 3 is a sectional plan on the line X X of Fig. 1.

A is a fire-place, with fire-door A' and ash-pit door A^2, suited for regulating admission of air as required.

Instead of a fire-place with grate for burning solid fuel, any known burners for liquid or gaseous fuel may be employed.

Above the combustion-chamber B is placed a metal retort C, which is inclosed within a refractory casing C' to protect the metal from excessive local heating. The inclosed retort is situated in a heating-chamber B', into which the hot products of combustion ascend

by side ports B^2 and from which they pass by central ports B^3 into a flue B^4, communicating with a chimney B^5. The front part of the retort C communicates freely with a still-head C^2, provided with a pressure-gage C^3 and safety-valve C^4. The exposed end of the retort C is closed by a readily-removable cover C^5, provided with a glass gage to show the level of the liquid in the retort.

D is a pipe-coil situated in a tank D', in which circulation of water is maintained. The upper end of the coil D communicates by a pipe with the still-head C^2 and its lower end opens into a hollow column D^2, which is provided with a glass gage D^3 and has at the bottom an outlet-pipe D^4, furnished with a stop-cock or valve.

E is a pump for forcing the oil to be treated by a pipe E' into the retort C, this pipe preferably extending nearly to the farther end of the retort. By another pipe E^2, furnished with a cock or valve, the contents of the retort can be drawn off, or this pipe may communicate with a second retort, which in like manner may be connected with a third, so as to form a series of any required number.

F is an air-compressing pump, by which air or suitable gas is forced by a pipe F' into the still-head C^2, or it might be into any other part of the apparatus which is in communication with the still-head. The retort C being partly charged with oil by the pump E, and the spaces in the retort C in the still-head C^2 and in the condensing-coil D and column D^2 being charged with air or gas to the desired pressure, the retort is heated, vaporizing the oil under pressure. The oil-vapor is condensed in passing through the coil D and the liquid distillate collects in the column D^2, and is drawn off either continuously or intermittently into suitable receptacles, in which such gas as may be dissolved in the liquid is liberated and can be collected.

By a pipe and cock or a suitably-loaded safety-valve D^5 gas may be withdrawn from the space above the liquid in the column D^2.

Although we have shown one retort and condenser, there may be several sets of these in communication with the oil and gas pumps or with each other, suitable cocks or valves being provided in the communicating pipes, so that the several retorts may be worked simultaneously or in rotation. From time to time the cover C^5 of the retort may be removed to clear out residue. During the distillation such of the vapor as may be condensed in the still-head C^2, or such liquid as may prime up into the still-head, flows back into the body of liquid in the retort. By regulating the heat and pressure to which the retort is subjected the character of the distillate may be varied, and thus oils more or less light can be obtained to suit various uses. Also, the proportions of the parts may be varied, and, if necessary, means of cooling may be applied to the still-head C^2.

Having thus described the nature of our invention and the manner of carrying the same into effect, we claim—

The herein-described method of distilling mineral oils and like products, which consists in both vaporizing them and condensing the generated vapor under a regulated pressure of air or gas, substantially as specified.

In testimony whereof we have signed our names to this specification, in the presence of two subscribing witnesses, this 13th day of August, A. D. 1889.

JAMES DEWAR.
BOVERTON REDWOOD.

Witnesses:

OLIVER IMRAY,
Patent Agent, 28 Southampton Buildings, London, W. C.

JNO. P. M. MILLARD,
Clerk to Messrs. Abel & Imray, Consulting Engineers and Patent Agents, 28 Southampton Buildings, London, W. C.

3126

(No Model.) 5 Sheets—Sheet 1

C. M. PIELSTICKER.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

No. 477,153. Patented June 14, 1892.

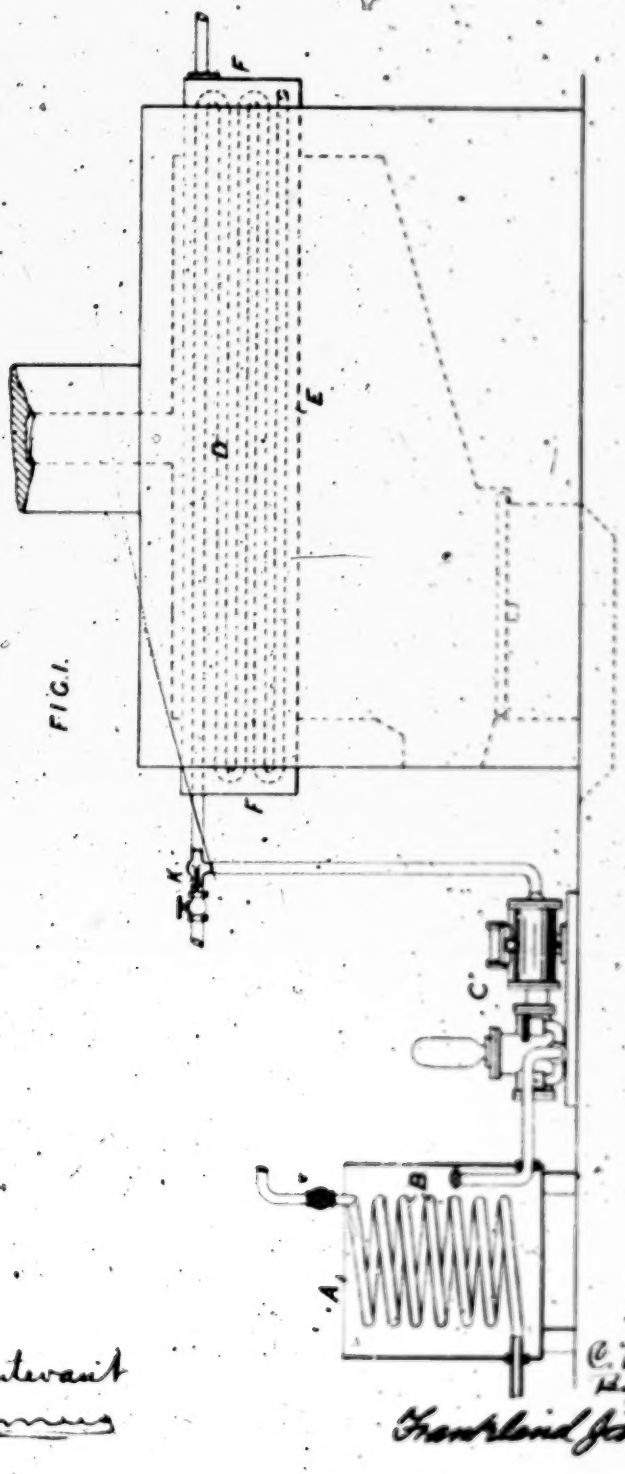


FIG. 1.

Witnesses
Chas. L. Stutevant
Stephen Jamieson

C. M. Pielsticker
by Atty
Frankland Jamieson

3128

(No Model.) 5 Sheets—Sheet 2.

C. M. PIELSTICKER.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

No. 477,153. Patented June 14, 1892.

FIG. 3.

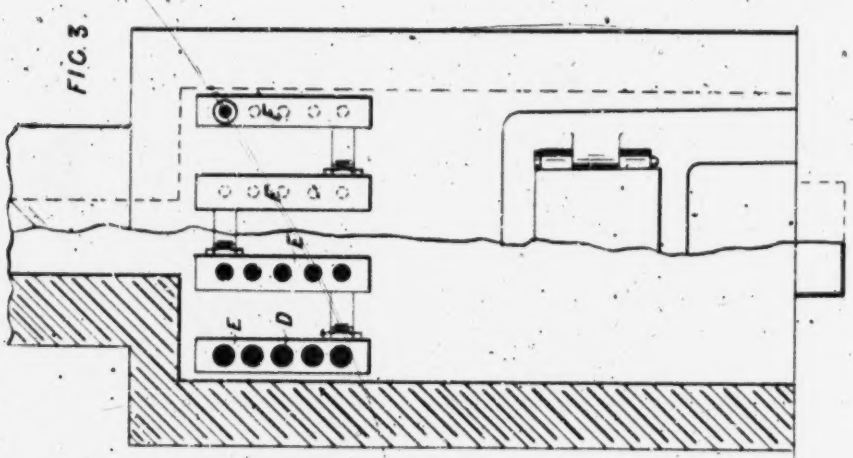
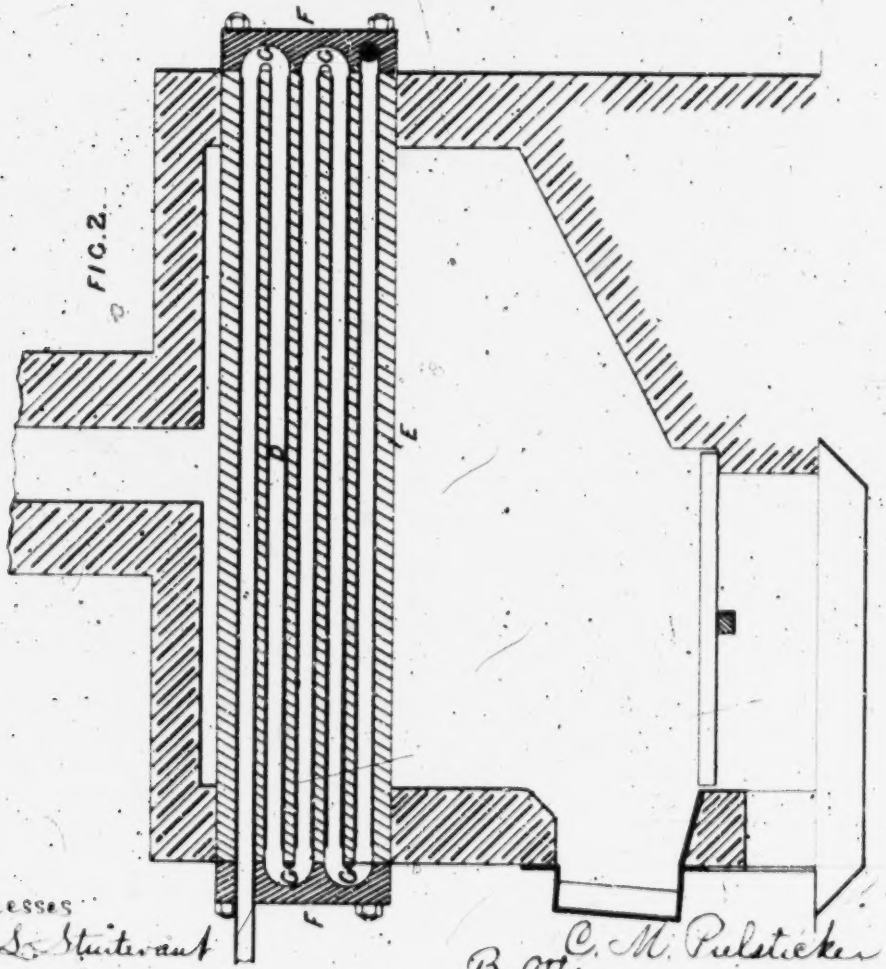


FIG. 2.



Witnesses
Chas. L. Stinterant
Stephen Jamms

C. M. Pielsticker
By Atty Hazard & Jamms

3130

(No Model.) 5 Sheets—Sheet 3.

C. M. PIELSTICKER.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

No. 477,153. Patented June 14, 1892.

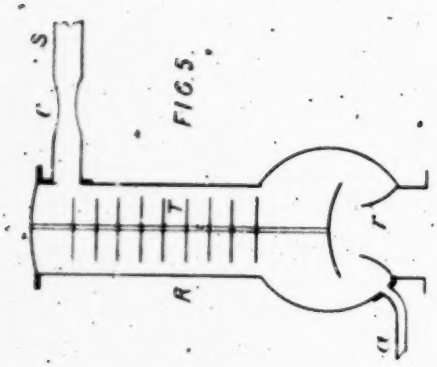


FIG. 5.

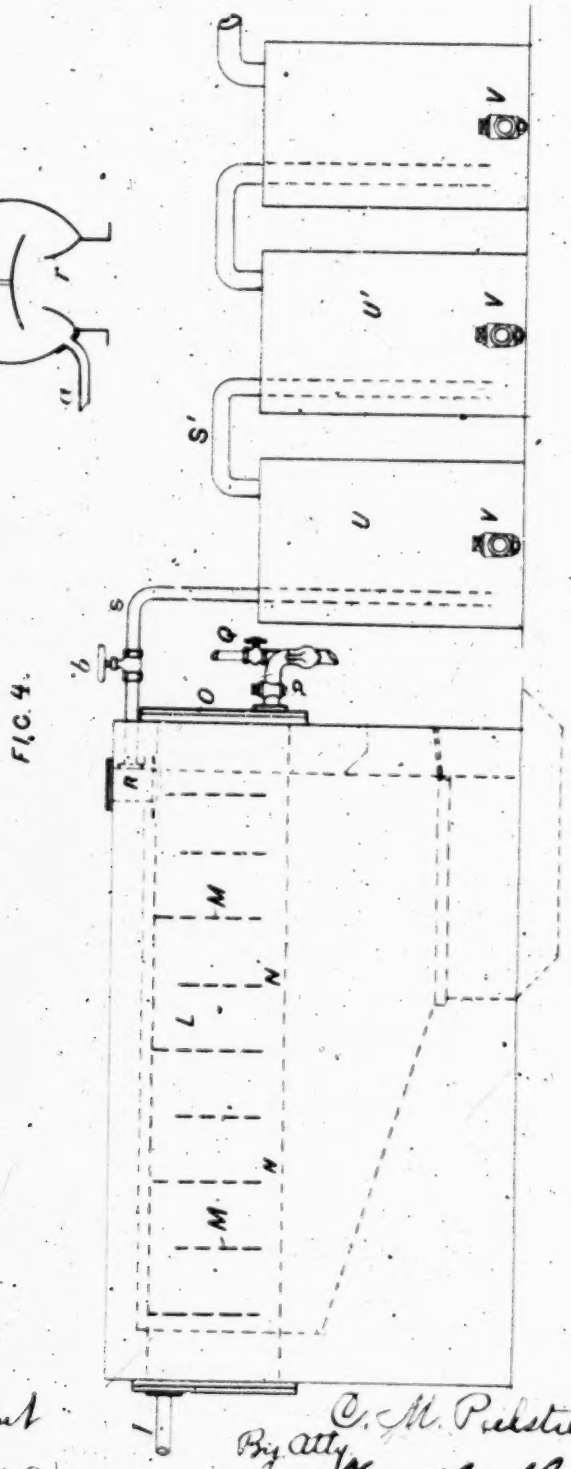


FIG. 4.

Witnesses
Chas. L. Sturtevant
Stephen Jarman

C. M. Pielsticker
By Atty
Frankland & Jarman

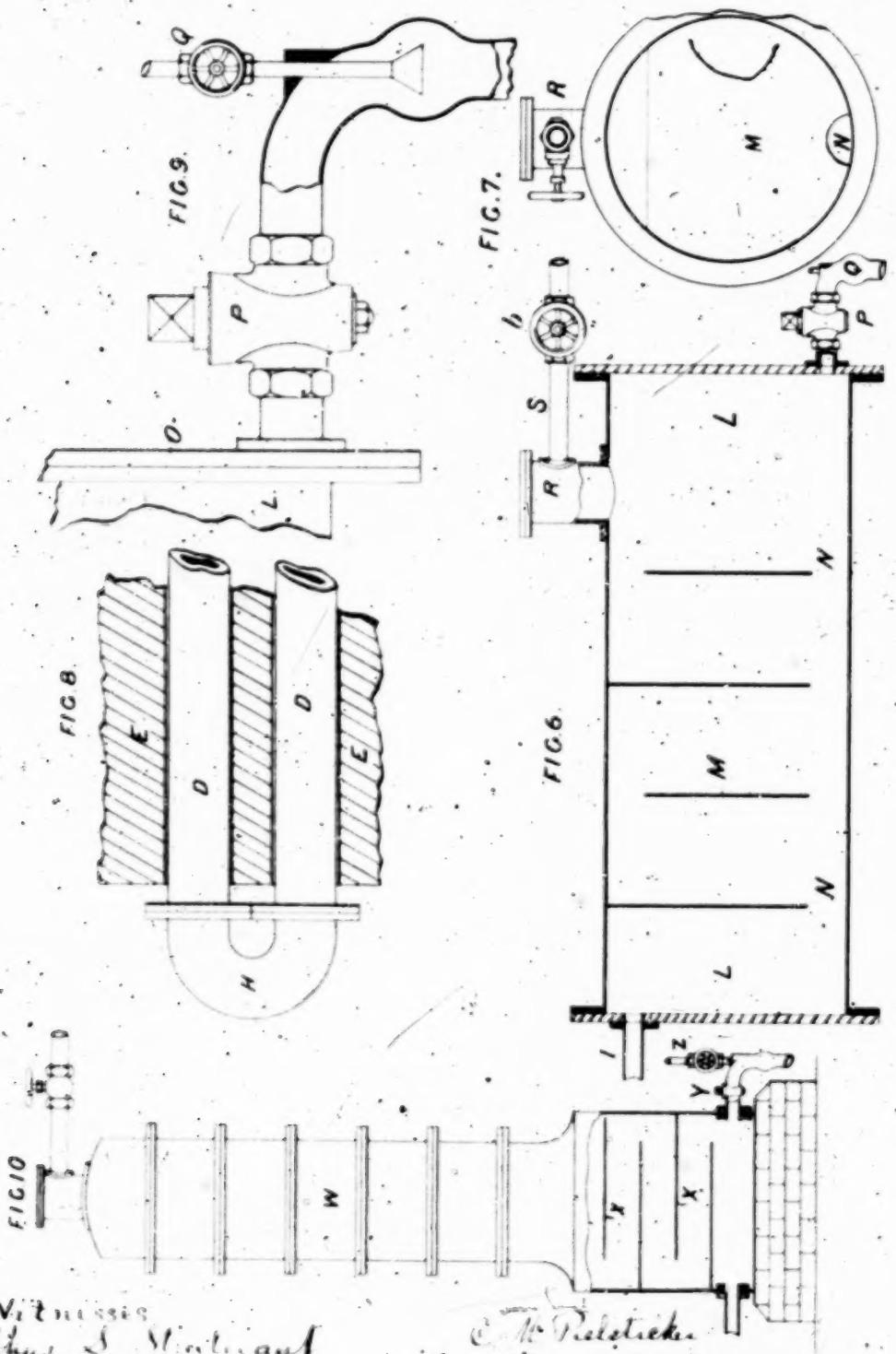
3132

(No Model.) 5 Sheets—Sheet 4.

C. M. PIELSTICKER.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

No. 477,153. Patented June 14, 1892.



Witnesses
Chas. L. Norton
[illegible]

C. M. Pielsticker
By Cilly Frankland & Jannus

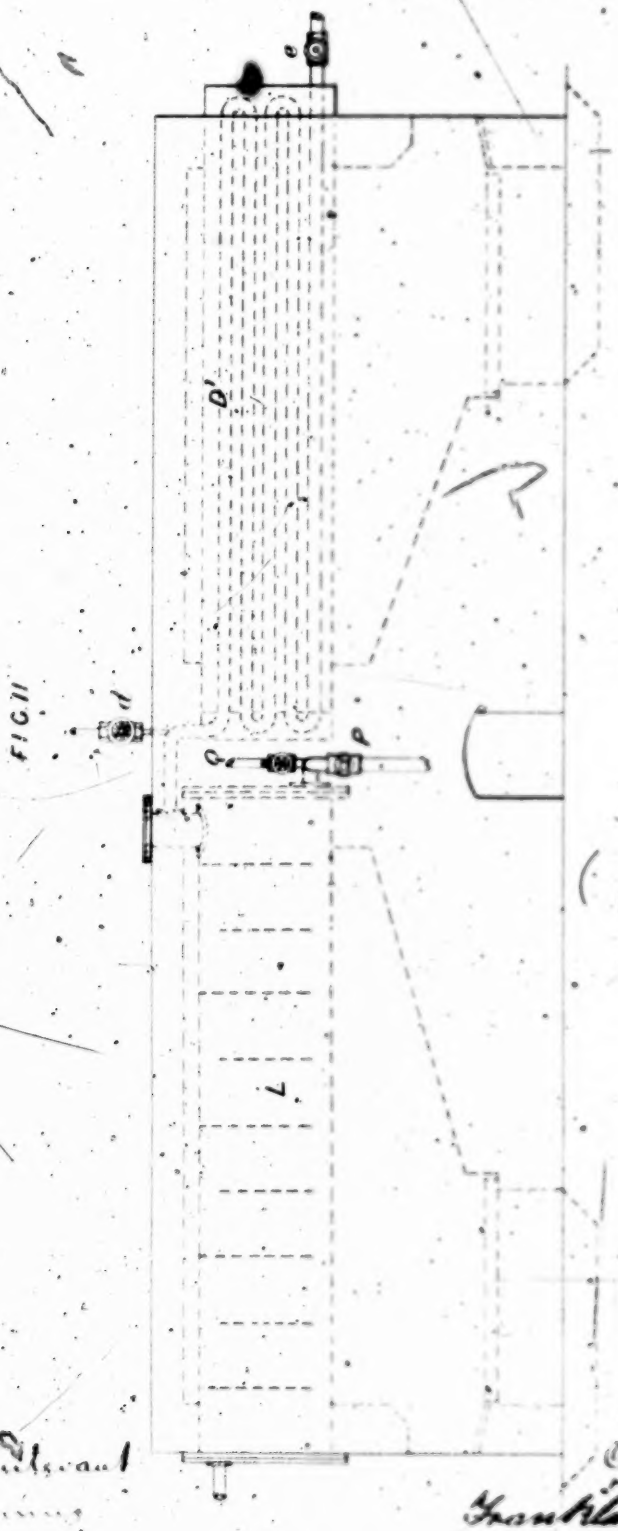
3134

(No Model.) 5 Sheets—Sheet 3.

C. M. PIELSTICKER.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

No. 477,153. Patented June 14, 1892.



Witnesses:
Chas. L. Shepard
Stephen Fleming

C. M. Pielsticker
By
Frank Van Santvoord

UNITED STATES PATENT OFFICE.

CARL MARIA PIELSTICKER, OF LONDON, ENGLAND.

DISTILLATION OF HYDROCARBON OR OTHER OILS.

SPECIFICATION forming part of Letters Patent No. 477,153, dated June 14, 1892.

Application filed November 26, 1890. Serial No. 372,721. (No model.) Patented in England April 28, 1890, No. 6,466, and January 4, 1891, No. 1,308; in France November 26, 1890, No. 209,809; in Belgium November 26, 1890, No. 92,883; in Spain November 26, 1890, No. 11,511; in Italy December 31, 1890, No. 28,644, and in Austria-Hungary June 16, 1891, No. 53,380.

To all whom it may concern:

Be it known that I, CARL MARIA PIELSTICKER, a subject of the Queen of England, residing at London, in the county of London and Kingdom of England, have invented certain new and useful Improvements in the Continuous Distillation of Hydrocarbon or other Oils and Liquids, (for which I have obtained Letters Patent in England, dated April 28, 1890, No. 6,466, and January 4, 1891, No. 1,308; in France, dated November 26, 1890, No. 209,809; in Belgium, dated November 26, 1890, No. 92,883; in Italy, dated December 31, 1890, No. 28,644; in Spain, dated November 26, 1890, No. 11,511, and in Austria-Hungary, dated June 16, 1891, No. 53,380,) of which the following is a specification.

My invention relates to improvements in the distillation of hydrocarbon or other oils and liquids, by means of which the operation of distillation is conducted in a continuous manner.

In the specification to Letters Patent granted to me in Great Britain under No. 1,706 and dated April 10, 1882, I described a method in which the hydrocarbon oil was forced under pressure by means of a force-pump or a steam-injector into a coil open at the other end, in which coil the oil was heated to its distilling-point, the heated oil entering from the coil into a heated retort, in which it was vaporized and again condensed in a cooler connected with the retort. In employing this apparatus it was found difficult to so regulate the temperature of the coil that all the oil at once assumed vapor form on entering the retort, while at other times the coil became so superheated that a portion of the oil became converted into permanent gas. Moreover, the coil, being directly exposed to the action of a high temperature, was burned through in a short time, and finally it was found impossible to clean the coil from the carbon deposited therein from the oil passing through it.

In the improved apparatus, which I will now proceed to describe by reference to the accompanying drawings, the above-mentioned defects have been obviated and a more perfect operation attained.

On the accompanying drawings, Figure 1 is an elevation showing general arrangement of oil tank or pump and heating-coil; Fig. 2, an elevation showing the arrangement of a retort and condenser. Fig. 3 is an enlarged section through the dome and goose-neck; Fig. 4, a longitudinal section through heating-coil; Fig. 5, an end sectional elevation of the same. Fig. 6 is a longitudinal section through the retort, showing arrangement of baffle-plates. Fig. 7 is a transverse section through the same. Fig. 8 illustrates the methods of connecting the pipes by means of short bends. Fig. 9 is a detail of the tar-outlet from retort fitted with steam-ejector; Fig. 10, a sectional elevation of a column-still; and Fig. 11 is an elevation showing the arrangement of a retort and second heating-coil.

A is the oil-tank; *a*, oil-pipe; B, steam-coil; *b*, valve or outlet of retort; C, pump or injector; *c*, contraction or valve in goose-neck; D, heating-coil; *d*, steam-injector to second coil; D', second heating-coil; E, block of iron; *e*, valve on second coil; F, iron cover; G, channels; H, bends; I, inlet to retort; K, steam connection; L, retort; M, baffle-plates; O, movable cover of retort; N, passage at bottom of plate; P, outlet-valve on retort L; Q, steam-inlet to valve; R, the dome; *r*, cup inside dome; S, goose-neck; S', second bend; T, baffle-plates in dome; U', small vessel or condenser; U'', second vessel or condenser; V, draw-off cocks; W, column-still; X, baffle-plates in column-still; Y, draw-off cock for tar; Z, steam-injector.

The oil to be distilled is contained in a tank A, in which it is heated by means of a steam-coil B or otherwise. From this tank the oil is forced by means of a pump C or otherwise into a coil D, which is formed of a number of iron pipes—say ten feet long and, say, an inch and a half (more or less) in diameter—the ends of which are open and the whole of the pipes embedded or inserted into a solid block of iron or refractory material E, provided with longitudinal channels through their entire length, into which the pipes fit. The ends of the pipes are closed by means of an iron cover F, which is provided with channels to G, so that the pipes D form one continuous coil. In this case the cover F can be easily removed

and the pipes be occasionally cleared of the carbon deposited inside from the heated oil by simply forcing an iron rod through the length of each pipe forming the coil. I may connect the open ends of the pipes D by short bends H, which are also removable for cleaning in a similar manner. This construction of the heating-coil is a matter of great importance, since it is impossible to clear an ordinary coil of the requisite length from any carbon adhering inside. Moreover, the coil being loosely inserted into the block of iron or of refractory material E, the whole length of the coil is permitted free expansion, and the joints are in consequence kept tight.

I have found that by passing the oil through the coil with great velocity I in a great measure prevent the deposition of carbon or heavy matter which would soon choke up the coil. I now find it preferable to attain this object by graduating the diameter of the pipes D, forming the coil. For instance, if the entire length of the coil is two hundred feet I construct the first fifty feet of two-inch pipes, the second fifty feet of one-and-a-half-inch pipes, and the last hundred feet of one-inch pipes. I may, however, decrease the diameter of the coil only toward or at the inlet I into the retort.

Between the force-pump C and the inlet of the coil D a steam connection K is provided for the purpose of emptying the oil contained in the coil D at the end of the operation by a steam-blast into a retort L, into which the other end of the coil D leads; otherwise when the pumping is stopped the oil remaining in the coil D would speedily become carbonized and choke the coil.

Between the pump C and the coil D and between the coil D and retort L expansion-joints may be provided. The retort L is provided with a number of baffle-plates M, causing the oil-vapors to take a lengthened passage through the retort before they can enter the condenser. A passage N is left in the lower part of the baffle-plates in order to allow the flow of the tar or residuum to the draw-off cock.

The end of the retort opposite to the inlet of the oil is closed by a removable cover O. Nearly at the lower end of the cover is fitted a valve P for the removal of the tar or residue during the operation of distilling, a steam-inlet Q being connected with the tar-outlet in order to blow steam when the tar-outlet is opened, which not only assists in the removal of the thick tar or the residue, but more particularly prevents air from entering the retort, which air would form a dangerously-explosive mixture with the highly-heated oil-gases inside the retort. It will be evident that since a constant supply of oil is fed into the retort L and the residuum of this oil or other liquid entering the latter by preference from the highest point of the coil, being constantly removed during the distillation, this distillation thus becomes continuous.

A dome R and goose-neck S connect the retort with a condenser. The dome R may be enlarged at its base, forming a sphere, and may be provided at its lower end inside with a cup-shaped projection *c*, into which any oil collects which may condense in the dome R and from which it may be returned into the retort L or into the supply-tank A through the pipe *a*. This dome may be provided with a number of baffle-plates T, which force the vapors to come in contact with the inner surface of the dome R, where the heavier portion of them are caused to condense, and, returning to the more heated surface of the retort, are reduced in gravity and finally distil over and condense in the condenser.

The condenser may either be an ordinary coil or a surface condenser, the first bend of which reaches into a vessel U, nearly to the bottom of the latter, in which part of the vapors condenses, the uncondensed portion being led by the second bend S′ from the top of the first vessel U to the bottom of the second vessel U′, and so on through a series of condensing-vessels, which are all provided with draw-off cocks V, in which the vapors are successively condensed into oil of a number of graduated specific gravities heavier at the beginning of the series and lighter toward the end of the series; or, instead of this arrangement the products of distillation as they pass over from the retort L may be fractionally separated into a number of oils of graduated specific gravities by connecting the heating-coil with a column-still W, which may be similar to that used in the distillation of benzole, the body of which column-still I also divide by baffle-plates X, and a draw-off cock V for the tar or residue with steam-ejector Z. When it is intended to produce still lighter gravity oils, a valve *b* may be placed between the outlet of the retort L and the condenser U, which may be kept open only so far as to create a certain pressure of the gases inside the retort, or such pressure may be created by means of a steam-blast introduced into the goose-neck S and blowing in the opposite direction to the flow of vapors which distil over from the retort, or the goose-neck S may be contracted at some point *c* to a much smaller diameter.

In case the crude oil contains a considerable quantity of water, the latter may be separated from the oil by placing the baffle-plates horizontally into the retort, over which the oil and water flows, presenting in this manner a very extended surface, which is most conducive to rapid evaporation. The coil D and the retort L are kept at the temperature at which only the water distils off, while the oil pumped through the coil and retort is drawn off at the tar-cock Y free from water and in a subsequent operation may be subjected to distillation.

If the manufacture of permanent gas or of very light oil is intended, the retort L is directly connected with a second coil D′, similar to the first one D, steam which may previously

have been superheated being in preference simultaneously admitted with the oil-vapors into the second coil D′ by means of a steam-injector *d*, provided for the purpose. The second coil may be kept under pressure by means of a valve *e* or otherwise and may be connected with an expansion-chamber or gas holder and condenser of well-known construction.

My apparatus may also be used for the distillation of other liquids besides hydrocarbons—for instance, for fats and oils in the separation of fatty acids and glycerine; also, for the continuous production of distilled water from sea-water or the concentration of brine and alkaline solutions and the concentration of sugar solutions. The concentrated salt, alkaline, or other solution may be drawn off at the draw-off cock at the end of the retort.

Having fully described my invention, what I claim, and desire to secure by Letters Patent, is—

1. In an apparatus for the continuous distillation of oil, a supply-tank, a coil, connections between the two, means for heating both tank and coil, means for forcing the liquid from the supply-tank through the said coil, a steam jet or blast in connection with said coil, a retort through which the liquid is also forced, said retort being provided with baffle-plates and a draw-off cock, a steam-ejector fitted to said draw-off cock, a second heating-coil in connection with the retort, an expansion-chamber connected with one end thereof, a condenser in connection therewith, and a gas holder or other receptacle.

2. In an apparatus for the continuous distillation of oil, a supply-tank, means for heating the same, a heating-coil comprising a series of pipes D, blocks E, incasing the same, removable covers closing and connecting the ends of the pipes, said pipes D gradually increasing in diameter from the inlet to the outlet, connections between this heating-coil and the supply-tank, a pump or equivalent device located between the two for forcing the oil through the heating-coil, a retort in connection therewith, a steam jet or blast attached to the heating-coil, a draw-off cock attached to the retort, a steam-ejector fitted to said cock, and a condenser in connection with the retort.

3. In an apparatus for the continuous distillation of oil, a supply-tank, means for heating the same, a heating-coil comprising a series of pipes, blocks of cast-iron or refractory material incasing the same, and removable covers closing and connecting the ends of the pipes, connections between said tank and coil, a pump or equivalent device located between the two, a retort in connection therewith, a draw-off cock for said retort, and a condenser in connection with the retort.

4. In the herein-described apparatus, the combination, with the retort and condenser, of a dome B, attached to the retort, having an annular cup at its base, and a pipe connection between the upper part of said dome and the condenser and having a contracted portion, substantially as described.

CARL MARIA PIELSTICKER.

Witnesses:
WALTER JOSEPH NORWOOD,
TOM FRANCIS BARNES,
T. F. BARNES,
All of 17 *Gracechurch Street, London, E. C.*

3140

J. S. LANG.

APPARATUS FOR DISTILLING HYDROCARBON OILS.

APPLICATION FILED APR. 2, 1909.

954,575.

Patented Apr. 12, 1910.

2 SHEETS—SHEET 1.

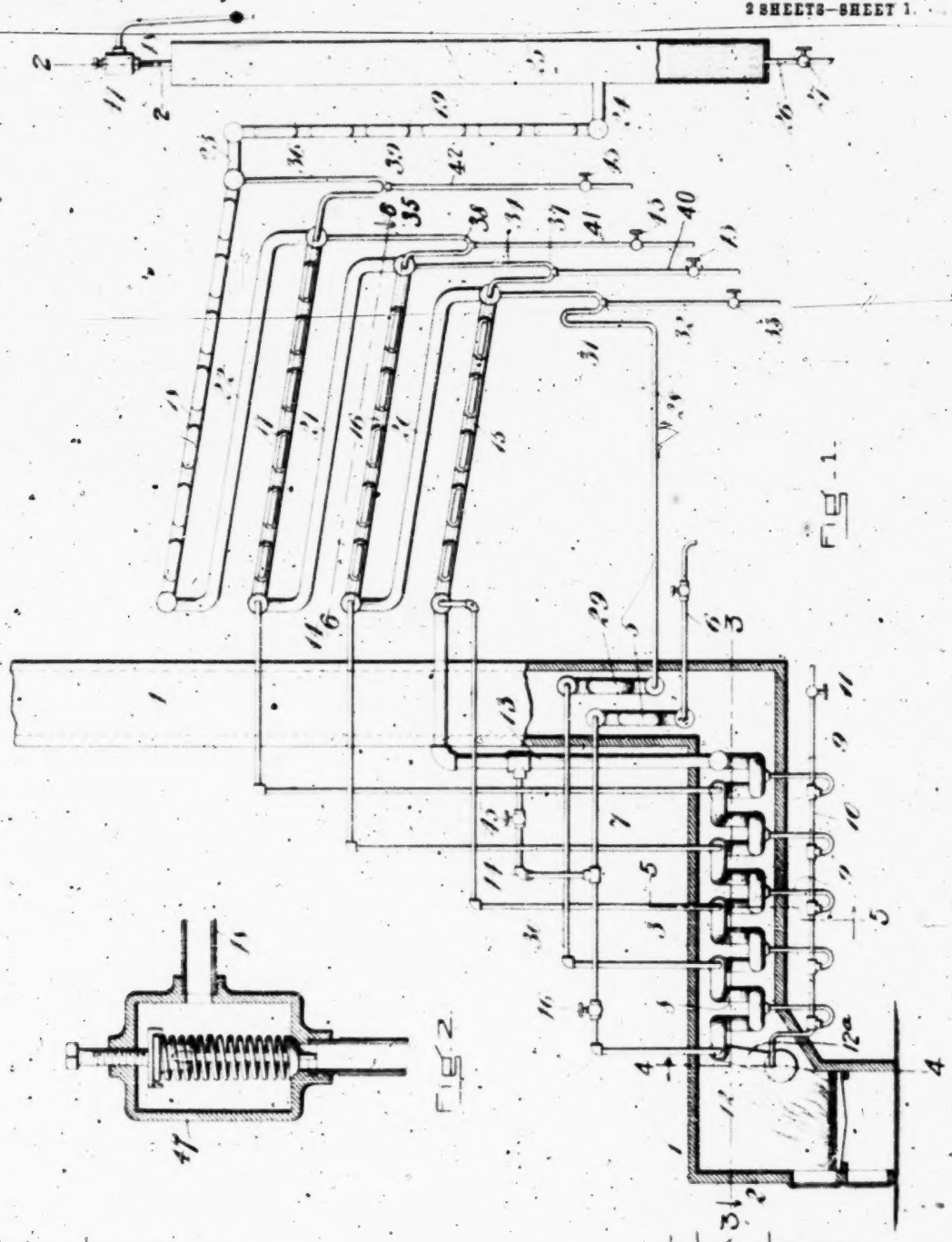


Fig. 1.

Fig. 2.

WITNESSES:

M. E. Flaherty

W. P. O'Brien

INVENTOR:

James S. Lang

by his attys

Clarke Ramsey & Cowles

3142

J. S. LANG.

APPARATUS FOR DISTILLING HYDROCARBON OILS.

APPLICATION FILED APR. 2, 1909.

954,575. Patented Apr. 12, 1910.

2 SHEETS—SHEET 2.

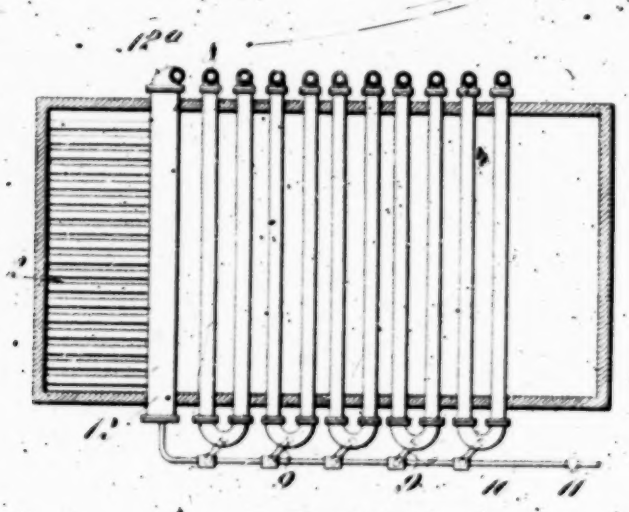


Fig. 3.

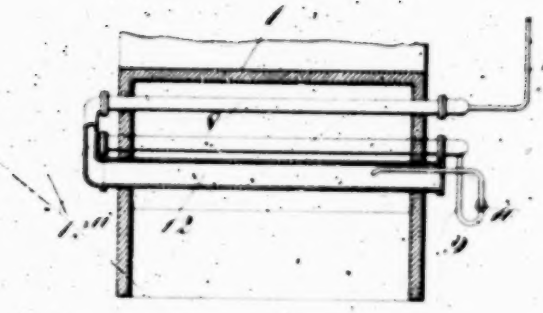


Fig. 4.

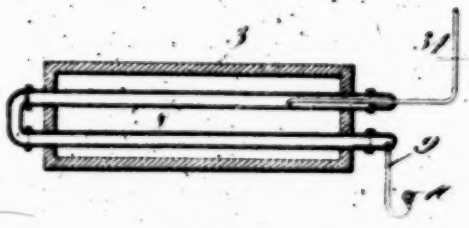


Fig. 5.

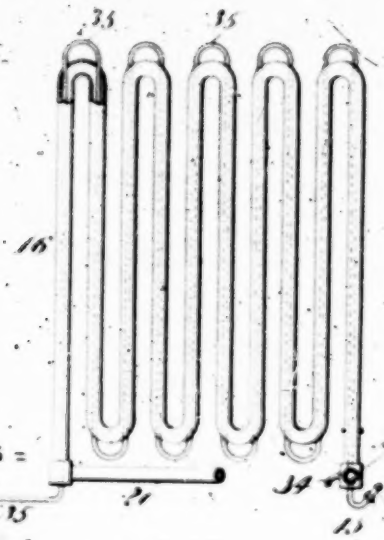


Fig. 6.

WITNESSES:

INVENTOR:

James S. Lang
by his attys
Clarke Raymond & Coale

UNITED STATES PATENT OFFICE.

JAMES S. LANG, OF BOSTON, MASSACHUSETTS.

APPARATUS FOR DISTILLING HYDROCARBON OILS.

954,575. Specification of Letters Patent. Patented Apr. 12, 1910.

Application filed April 2, 1909. Serial No. 487,841.

To all whom it may concern:

Be it known that I, JAMES S. LANG, of Boston, in the county of Suffolk and State of Massachusetts, a citizen of the United States, have invented a new and useful Improvement in Apparatus for Distilling Hydrocarbon Oils, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming a part of this specification, in explaining its nature.

Although it is my purpose to provide an apparatus of the above entitled character, the especial object of my invention is to provide an apparatus embodying means for effecting the destructive distillation of crude hydrocarbon oil for obtaining as an ultimate product a hydrocarbon oil of predetermined volatility and especially an oil of relatively high volatility or such high volatility that the oil will continue to vaporize at a relatively low temperature or that vaporization will continue when the oil is contained in snow and the vapor therefrom burned for melting the snow in accordance with the process described in my patent, No. 863,855, dated August 20, 1907.

The apparatus embodying my invention can best be seen and understood by reference to the drawing in which—

Figure 1 shows the apparatus diagrammatically and mainly in side elevation but partly in vertical section. Fig. 2 is a section taken on the line 2—2 of Fig. 1. Fig. 3 is a section taken on the line 3—3 of Fig. 1. Fig. 4 is a section taken on the line 4—4 of Fig. 1. Fig. 5 is a section taken on the line 5—5 of Fig. 1. Fig. 6 is a section taken on the line 6—6 of Fig. 1.

Before referring to the apparatus, however, it should be understood that at a given pressure the lower the volatility of a hydrocarbon oil the higher the temperature at which it will condense on which account the condensed oil will only give off vapor or an appreciable amount of vapor at a relatively high temperature. On the other hand, the higher the volatility of the oil the lower the temperature at which it will condense; in other words, the lower will be the temperature it takes to overcome its volatility. Consequently the condensed oil of high volatility will volatilize or give off an appreciable amount of vapor at a relatively low temperature. This principle I take advantage of in the apparatus constituting my invention and to which detailed reference will now be made.

Referring to the drawings, 1 represents a furnace. This furnace in so far as it is necessary to go into a description of the construction thereof, comprises a body portion 2 in which fuel is burned for generating heat, a relatively long-extending combustion chamber 3 through which the products of combustion are directed to pass, and a stack 4 into and through which the products of combustion pass from the combustion chamber. Located within the stack at a point preferably near the base portion thereof is what may be termed a primary heating coil 5. It is into this coil or primary heater that the crude hydrocarbon oil is first introduced to become vaporized therein by the heat products within and passing through the stack. The oil is led into the coil by way of an inlet pipe 6 and is preferably introduced under pressure.

Extending from the primary heater is an outlet pipe 7 which connects with the forward end of what may be termed a secondary or super-heater 8 located within the combustion chamber. This heater comprises a series of coils extending laterally back and forth to progress through the combustion chamber. The vaporized oil is introduced into the secondary heater from the primary heater by the way of the pipe 7 and as the vapor passes through the coils of the secondary heater it is subjected to a destructive distillation by the heat products within and passing through the combustion chamber. Owing to the fact that the secondary heater presents both a narrow and a somewhat extended passage the heat within the combustion chamber has full opportunity to effect such proper destructive distillation of the vaporized oil as may be desired to be obtained.

During the process of distillation undergone in the secondary heater the distillate as it passes off may leave a deposit or residue within the coils of the heater of a tarry nature. For the purpose of taking care of this tarry substance there connect with the heater at different sectional points throughout the same waste pipes 9 extending downwardly and connecting with a common pipe 10 through which the matter may be drawn off upon opening a cock 11 located within this pipe. I prefer, however, that the tarry matter or residue may be led back into a

retort 12 located within the combustion chamber at a point in front of the secondary heater or where it may be subjected to the direct influence of the heat from the burning fuel which will act to effect its further reduction. The deposit or residue will tend to work back into this retort from the pipe 10 since the chamber of the retort is located at a point below the coils of the secondary heater, the oil flowing into the retort tending simply to seek its level. In this connection also I would call attention to the fact that each of the waste pipes 9 is bent downwardly below the common pipe 10 before making its connection therewith, thereby forming a trap and preventing the entry or return of vapor through the pipe. Oil vaporizing in the retort 12 will pass directly to the secondary heater by way of the connecting pipe 12ª.

Extending from the rear end coil of the secondary heater is a pipe 13 connecting with a condenser 14. This condenser comprises a series of coils 15, 16, 17, 18 and 19 and it is with the bottom coil 15 that the pipe 13 connects. These coils of the condenser are progressively arranged one above the other and occupy an inclined position with the exception that the coil 19 has preferably a vertical disposition to facilitate the application of water for cooling this pipe, should such application be deemed desirable. The respective coils of pipes are severally connected, the bottom end of the coil 15 being connected with the top end of the coil 16 by a connecting pipe 20, the bottom end of the coil 16 being connected with the top end of the coil 17 by a connecting pipe 21, the bottom end of the coil 17 being connected with the top end of the coil 18 by a connecting pipe 22, and the bottom end of the coil 18 being connected with the top end of the coil 19 by a pipe 23. The pipe 19 connects at the bottom end thereof by a pipe connection 24 with a pipe receptacle 25 which receives the oil condensing in the coil 19. From the pipe receptacle 25 the oil may be drawn off, as occasion may require, through a draw-off pipe 26 controlled by a cock 27.

It will be understood that the vapor passing over from the secondary heater may condense in any one of the coils of the condenser depending upon the relative degree of volatility of the vapor passing through the respective coils. Some of the vapor having a relatively low degree of volatility will be condensed at a relatively high temperature and accordingly may condense in the first coil, or the coil 15, of the condenser. Vapor of slightly higher volatility will condense in the coil 16 of the condenser, or that coil in which the vapor will have cooled to a slightly lower degree of temperature than in the coil 15. In the same way vapor of a relatively increasing degree of volatility will condense in any one of the remaining coils of the condenser depending upon the degree of its volatility. Vapor of a relatively high degree of volatility will condense in the coil 19 and the condensed oil from this vapor is the oil I desire to obtain.

It is the ultimate object of my invention to secure only an oil of relatively high volatility or such oil as will condense only in the coil 19. I have accordingly provided means whereby oil condensed in any one of the coils 15, 16, 17 or 18 may be conveyed back to the secondary heater and there subjected to a further destructive distillation tending to reduce this oil to such condition that the distillate will be of a sufficiently high volatility to condense only in the coil 19. For this purpose there extends from the bottom end of the coil 15 a return pipe 28. This pipe connects with the coil 29 located in the stack of the furnace and thence with the secondary heater by a pipe 30. The coil 29, which forms a section of this return pipe, is located within the stack for the purpose of vaporizing the oil that may condense in the coil 15 of the condenser so that it may ultimately return to the secondary heater as vapor. Attention is also directed to the fact that the pipe 28 is bent at the point 31 to form a trap, some oil constantly remaining in this trap to prevent the entry or reentry of vapor through the return pipe.

Should it be desired to obtain some of the oil condensing in the coil 15, arrangement is made whereby this may be done by means of a draw-off pipe 32 connecting with the return pipe at the point of the trap formed therein, this draw-off pipe being controlled by a cock 33.

Inasmuch as the oil condensing in the coil 15 or the first coil of the condenser is an oil of low volatility, as it condenses at a relatively high temperature, it is necessary that the vapor from this oil should be subjected to a considerable degree of destructive distillation before the distillate will be reduced to a condition of high volatility or where it will condense in the last coil of the condenser and there be secured an oil of high volatility which is the oil I desire to obtain. On this account the part 30 of the return pipe, which connects with the secondary heater, connects with it at a sectional point near the front end of the heater so that the vapor entering the heater at this point will pass through the major portion of the heater in order that the proper destructive reduction of the oil may be obtained by reason of the protracted period of destructive distillation to which the vapor will necessarily be subjected. Connecting also with the secondary heater are return pipes from each one of the other coils of the condenser for returning oil that may condense in these coils, with the exception of

the last coil 19, the oil condensing therein escaping, as before described, into the receptacle 25 from which it may be drawn off. These return pipes are numbered 34, 35 and 36, respectively, the pipe 34 returning to the secondary heater from the bottom end of the coil 16, the pipe 35 from the bottom end of the coil 17 and the pipe 36 from the bottom end of the coil 18. In order that the oil returning through these respective pipes may be vaporized before entering the secondary heater I have provided for such vaporization of the oil by directing each pipe to return through a coil of the condenser below and next to the coil from which the pipe extends. As before described, the coils of the condenser are successively or progressively arranged, one above the other, and not only are they inclined so that oil condensing in each coil will flow to the bottom end thereof, but the coils are so far separated one above the other that oil returning from the bottom end of one coil may flow back through the return pipe passing through the adjacent coil, the oil tending simply to seek its level. Now as the oil passes through that portion of the return pipe contained in the coil below and adjacent to the coil of the condenser from which the oil is returning it will be subjected to a higher degree of temperature from the vapor within this pipe than the temperature within the coil from which it returns. In other words, the temperature in the coil through which the return pipe extends will be so high as to vaporize the oil contained within the return pipe so that it may ultimately return to the secondary heater in the form of vapor prior to its further reduction.

In connection with the return pipes 34, 35 and 36 attention is directed to the fact that these pipes connect with the secondary heater at different sectional points dependent upon the relative degree of volatility of the oil or vapor returning through the pipes. In other words, the oil condensing in the pipe 16 returning through the return pipe 34 will be of a lower degree of volatility than the oil condensing in the coil 17 and the oil condensing in this coil in turn will be of lower volatility than that condensing in and returning from the coil 18. Accordingly the respective return pipes connect with the secondary heater at such points that the return vapor may be subjected to a greater or less degree of destructive distillation dependent upon the degree of its volatility when it enters the secondary heater. The pipe 34 returning from the coil 16 connects accordingly with the secondary heater at a sectional point some distance removed from the end of the heater and just forward of the point where the pipe 30, returning from the coil 15, connects with the heater. The pipe 35 returning from the coil 17 will connect with the heater at a sectional point just forward of where the pipe 34 connects therewith but nearer the end of the heater, while the pipe 36 connects with the heater at a sectional point still nearer the end thereof inasmuch as the oil returning through this pipe has almost the requisite degree of volatility and so need be subjected to but slight further destructive distillation in order to obtain its proper reduction. In further connection with the return pipes 34, 35 and 36 it is to be observed that each one of these pipes is bent to form a trap, the pipe 34 being bent to form the trap 37, the pipe 35 to form the trap 38 and the pipe 36 to form the trap 39. These traps by the oil remaining in them prevent the entry or reentry of vapor through the respective pipes.

It may be desired to draw off oil condensed in any one of the coils 16, 17 or 18, and provision is made for doing this by the draw-off pipes 40, 41 and 42 connecting respectively with the return pipes from the respective coils at the points of the traps formed therein, each of the draw-off pipes being controlled by a cock 43.

It is sometimes found necessary or desirable to use a crude oil in the apparatus, which is of a very complex nature. In other words, the crude oil contains oils of a highly volatile nature which if subjected to a degree of temperature more than sufficient to vaporize them would be converted into gas. I have accordingly provided in the apparatus shown means whereby when treating crude oil of the above character the oil may only be vaporized and sent directly to the condenser without being subjected to any destructive distillation. The highly volatile oils in the crude oil thus vaporized will be condensed and that portion of the oil condensing in the last coil of the condenser may be drawn off and saved in the manner described above. The remaining oil condensing in the condenser will be returned to the secondary heater from that portion of the condenser in which it may be condensed, and in the secondary heater will be subjected to such destructive distillation as will secure its proper reduction.

The means I have provided for primarily preventing the destructive distillation of the crude oil in question is the pipe 44 interposed between the pipe 7, which connects the primary heater or vaporizer with the secondary heater, and the pipe 13 which joins the end of the secondary heater to the condenser. In this auxiliary connecting pipe 44 is located a valve 45. A valve 46 is also located in the pipe 7 beyond the point where the pipe 44 connects therewith, with the effect that by closing the valve 46 and opening the valve 45 the oil vaporized in the primary heater will pass directly to the condenser.

When oil is treated that does not contain

oils of a relatively high degree of volatility and which needs primarily a destructive distillation then the valve 45 is closed and the valve 46 opened by which means the oil vaporized in the primary heater will pass directly to the secondary heater.

Inasmuch as it is not my purpose to obtain gas as an ultimate product through the destructive distillation of oil treated in the apparatus, it is not necessary to subject the oil in the secondary heater to any extreme degree of heat, a normal fire only being maintained in the furnace. Though precautions may be taken to prevent an excessive heating of the oil and its conversion into gas, yet gas may form in the apparatus. I have arranged to take care of this gas by providing an escape valve 47. This valve may be any one of a number of well known varieties and is preferably arranged in the top of the receptacle. The valve 47 is so set as to allow the gas to escape through the valve and the pipe 48 connecting with it, when the pressure of gas within the system reaches a determinate degree of compression above the pressure normally maintained therein. The gas so escaping may be saved or it may be conveyed back into the body of the furnace and burned.

The operation of the apparatus is briefly as follows: Crude oil preferably under pressure is introduced by way of an inlet pipe 6 into the primary heating coil 5 where it becomes vaporized. Thence the vapor passes by way of an inlet pipe 7 to the secondary or super-heater 8 where the vapor is subjected to a destructive distillation. Any oil or tarry matter that may collect in the secondary heater may be drawn off by way of the waste pipes 9 and connecting pipe 10 upon opening the cock 11 located in the pipe 10 or by closing this cock the tarry matter may be conveyed back to a retort 12 where the oily product may become vaporized and again pass by the way of the pipe 12ª into the secondary heater. The vapor having undergone a destructive distillation in the secondary heater will pass out of this heater by way of the pipe 13 to the condenser 14 and will pass through the several coils 15, 16, 17 and 18 of the condenser to a coil 19, that is, if the vapor is of sufficiently high volatility. Vapor condensing in the coil 19 passes over by way of the connecting pipe 24 to a receptacle 25 where the condensed vapor or oil may be drawn of. Oil condensing the primary coil 15 of the condenser is conveyed back by way of a return pipe 28 to a vaporizing coil 29 arranged in the stack whence the vapor returns by way of the pipe 30 to the secondary heater. If desired, oil condensing in the coil 15 of the condenser may be drawn off by way of a pipe 32. Oil condensing in any one of the pipes 16, 17 or 18 of the condenser is returned to the secondary heater at different sectional points therein by the respective return pipes 34, 35 and 36, these pipes passing in turn through the coil of the condenser next adjacent to the coil from which they return on which account the returning oil will become vaporized before entering the secondary heater. In case it is desired to obtain oil condensing in any one of the coils 16, 17 or 18 of the condenser such may be obtained by drawing it off by way of the draw-off pipes 40, 41 and 42 connecting with the respective coils of the condenser, each pipe being controlled by a cock 43.

If by reason of the nature of the oil it is not thought desirable to subject the oil to destructive distillation in the secondary heater the vapor from this oil produced in the primary heater may be led directly to the condenser by way of the outlet pipe 7 and connecting pipe 44, the valve 45 being opened and the valve 46 being closed. Ordinarily in the operation of the apparatus the valve 45 will be closed and the valve 46 opened that is, when an oil is being used which it is desired to subject not only to the influence of the primary heater, but also to the influence of destructive distillation in the secondary heater. In case gas is formed in the apparatus this gas may escape through a escape valve 47 arranged in the top of the standpipe or receptacle 25, that is, when the gas reaches a degree of compression sufficient to open the valve.

Having thus fully described my invention I claim and desire to secure by Letters Patent of the United States:—

1. In an apparatus of the character specified, the combination of a furnace, a heater comprising a series of coils progressively arranged, a condenser comprising a series of coils also progressively arranged, and return pipes from said condenser to said heater said pipes connecting with the coils of said condenser for returning the oil condensing therein to said heater and which coils connect with said condenser and return to connect with said heater at sectional points relatively commensurate with the order of progression of their respective coils.

2. In an apparatus of the character specified, the combination of a furnace, a heater comprising a series of coils progressively arranged, a condenser comprising a series of coils also progressively arranged, return pipes from said condenser to said heater said pipes connecting with the coils of said condenser for returning the oil condensing therein to said heater and which coils connect with said condenser and return to connect with said heater at sectional points relatively commensurate with the order of progression of their respective coils, and mean

whereby the oil returning through said pipes may be vaporized before entering said heater.

3. In an apparatus of the character specified, the combination of a furnace having a combustion chamber, a heater located in said combustion chamber, the heater comprising a series of coils progressively arranged, an auxiliary retort located within said chamber, and drain pipes connecting with said heater at sectional intervals therein and which connect with to empty into said retort for returning to said retort the tarry residue that may accumulate in said heater, each of said pipes being bent to form a trap.

4. In an apparatus of the character specified, the combination of a furnace having a combustion chamber and stack rising from said chamber, a primary heater, means whereby oil may be introduced into said primary heater, a secondary heater located in said combustion chamber, a connection between said primary and secondary heaters, a condenser of sectional character with which said secondary heater connects, a return pipe extending from the primary section of said condenser and returning to said secondary heater, said return pipe comprising in part a connection subjected to the heat from said furnace, and a series of return pipes extending from said condenser at different sectional points therein to connect with said secondary heater, each of which pipes is arranged to return through a section of the condenser in which the vapor therein during the operation of the apparatus is at a higher temperature than the vapor in that section of the condenser from which the pipe returns.

5. In an apparatus of the character specified, the combination of a furnace, a primary heater, means through which oil is introduced into said heater, a secondary heater, a connection between said heaters, a condenser, a connection between said secondary heater and condenser, means whereby a direct connection may be had between said primary heater and condenser, and a series of return pipes between said condenser and said secondary heater whereby vapor condensing at different sectional points therein may be returned to said secondary heater.

6. In an apparatus of the character specified, the combination of a heater and a condenser with which said heater connects, return pipes from said condenser to said heater, said pipes conecting with said condenser at different sectional points thereof for returning oil condensing therein to said heater, each of said pipes returning through a portion of the condenser in which the vapor therein during the operation of the apparatus is at a higher temperature than the vapor in that section of the condenser from which the pipe returns and which pipes connect respectively with the heater at different sectional points from the end of said heater.

7. In an apparatus of the character specified, the combination with a heater, of a condenser with which the heater connects and a return pipe from said condenser connecting with said heater for returning to said heater oil condensing in said condenser, said pipe returning to the heater through a portion of the condenser in which the vapor therein during the operation of the apparatus is at a higher temperature than the vapor in that part of the condenser in which the returning oil is condensed, whereby said oil may be vaporized before its return to the heater.

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3150

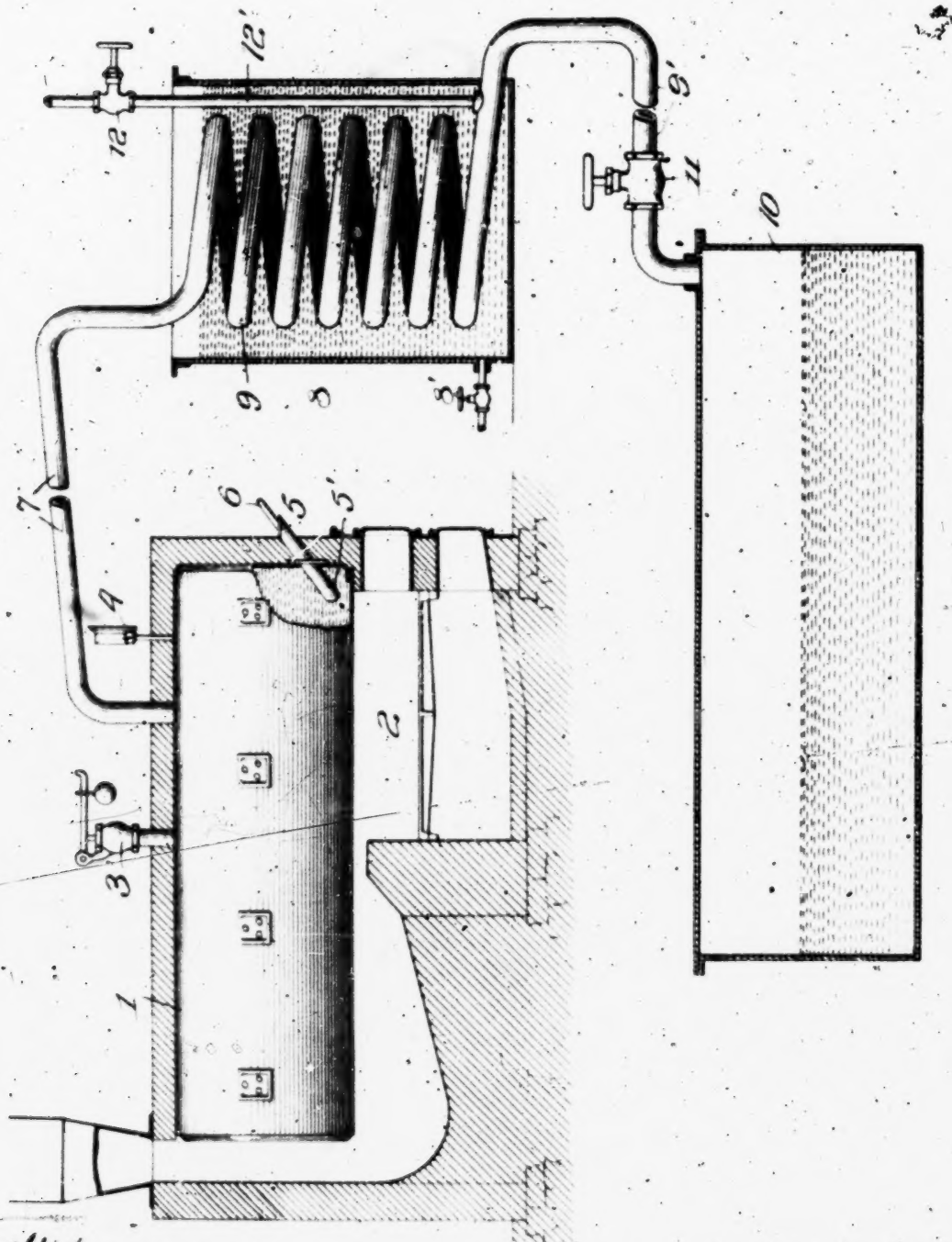
W. M. BURTON.

MANUFACTURE OF GASOLENE.

APPLICATION FILED JULY 3, 1912.

1,049,667.

Patented Jan. 7, 1913.



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UNITED STATES PATENT OFFICE.

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MANUFACTURE OF GASOLENE.

1,049,667. Specification of Letters Patent. Patented Jan. 7, 1913.

Application filed July 3, 1912. Serial No. 707,424.

To all whom it may concern:

Be it known that I, WILLIAM M. BURTON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in the Manufacture of Gasolene, of which the following is a specification.

My invention relates to an improvement in the treatment of the high boiling-point residual portions, and particularly the residue of the distillation of the paraffin group or series of petroleum after the lower boiling-point distillates have been removed to obtain a low boiling-point product of the same group or series.

The great and growing demand during the past ten years for gasolene has induced a large increase in the supply by improvements in the method of distilling from crude petroleum the naphthas, the boiling points of which range from about 75° F. to 350° F. This leaves the illuminating oils, the boiling points of which range from about 350° F. to about 600° F., and the lubricating oils and waxes and, as residue, fuel-oil and gas-oil, with boiling-points ranging from about 600° F. to 700° F. The increasing demand for gasolene has induced attempts to obtain it from this residue; but these attempts, while successful in producing gasolene, have invariably, so far as I am aware, as the result of lowering the boiling point, changed the general formula of the paraffin group $(C_nH_{2n}+2)$ to that of the ethylene group (C_nH_{2n}), rendering the product unmarketable because undesirable by reason of its offensive odor, for the removal of which no suitable treatment has been found.

A known method of treating the fuel and gas oils, forming the aforesaid residue of distillation of the paraffin series of petroleum, for obtaining therefrom a low boiling-point product involves subjecting the liquid to be treated to a temperature sufficiently high to secure so-called destructive distillation, and conducting the resultant vapors through a condenser by way of a pipe or conduit connecting it with the still, but having a loaded valve interposed in the conduit between the condenser and still to maintain pressure in the latter of the vapors of distillation on the liquid. While this practice produces the desired effect of lowering the boiling point of the liquid, the condensed product, for reasons which I do not attempt to explain, is found to have been converted into distillates belonging to the objectionable ethylene group, referred to.

The object of my invention is to provide a method of treating the aforesaid residue of the paraffin group of petroleum by distillation and condensation of the vapors thereof, whereby the resultant product of low boiling-points shall be of the same paraffin series and thus free from the objection mentioned or, in other words, whereby conversion of the petroleum of that series into products belonging to the ethylene series shall be avoided. This object I accomplish by raising the boiling point of the liquid residue and increasing the heat-influence thereon while undergoing distillation by maintaining back-pressure on said liquid of the vapors arising therefrom by distillation, as has hitherto been done as aforesaid, and also maintaining the vapors themselves under pressure throughout their course from the still through the condenser and while undergoing condensation.

Suitable apparatus devised for the practise of my improvement is illustrated in the accompanying drawing by a broken view in vertical longitudinal section, diagrammatic in character, showing parts in elevation.

A boiler-like holder 1 for the liquid residue to be treated surmounts a fire-chamber 2 and is shown to be equipped with a safety-valve 3 to relieve excessive pressure in the holder, a pressure-gage 4, and a temperature-gage 5, the preferable construction of which is that illustrated of a tube 5^1 extending inclinedly into the holder through its head and closed at its inner end, for containing mercury, or by preference oil, and adapted to have withdrawably inserted into it through its outer, open end a suitable thermometer 6 for immersion into the contents of the tube under subjection to the heat in the holder. A conduit 7 leads from the top of the holder and inclines upwardly therefrom, to induce the return-flow into it of unvaporized portions of the liquid, to a condenser 8, the tank of which is shown to be provided with a lower draw-off cock 8^1. The condenser-coil 9 discharges at its lower end through a pipe-extension 9^1 thereof, of any desired length, into a receiver 10 for the products of condensation. In this pipe, and thus beyond the discharge-end of the coil, is contained a shut-off valve 11, and it is desir-

able to equip the coil with a relief-valve 12, shown on the upper end of a pipe 12¹ rising from near the lower end of the coil through the top of the condenser-tank, for relieving the gas-pressure which is liable to accumulate in the coil and obstruct the action of the apparatus.

The valve 11 is normally closed. From a supply of the aforesaid liquid residue contained in the holder 1, heat from the fire-chamber distills the volatile constituents, and the resultant vapors course through the conduit 7 and coil 9, wherein they are condensed. With the valve 11 tightly closed against the escape of the products of condensation, the vapors of distillation accumulate and thereafter exert a high pressure amounting from about 4 to about 5 atmospheres upon the liquid in the holder or still, raising the boiling-point from 500° F.–600° F. to 750°F.–800° F.; and this pressure of the vapors combined with their contained heat greatly enhances the conversion of the high boiling members of the paraffin series into low boiling members of the same series. The valve 11 is opened from time to time to draw off the products of condensation into the receiver 10. In fact, the intervals of drawing off should be sufficiently frequent to avoid filling the coil with liquid, for the most satisfactory operation of the apparatus. The resultant gasolene is a product belonging to the paraffin series, the same as the petroleum residue from which it was distilled. I do not herein account for the effect of the back-pressure from the extreme end of the condenser-coil upon the contents of the holder 1 in preventing transformation of the paraffin series into the objectionable ethylene series, but it is the fact that such effect ensues.

What I claim as new and desire to secure by Letters Patent is:—

1. The method of treating the liquid-portions of the paraffin-series of petroleum-distillation having a boiling point upward of 500° F. to obtain therefrom low-boiling-point products of the same series, which consists in distilling at a temperature of from about 650 to about 850° F. the volatile constituents of said liquid; conducting off and condensing said constituents, and maintaining a pressure of from about 4 to about 5 atmospheres on said liquid of said vapors throughout their course to and while undergoing condensation.

2. The method of treating the liquid-portions of the paraffin-series of petroleum-distillation having a boiling point of upward of 500° F. to obtain therefrom low-boiling-point products of the same series, which consists in distilling off at a temperature of from about 650 to about 850° F. the volatile constituents of said liquid, conducting off and condensing said constituents, maintaining a pressure of from about 4 to about 5 atmospheres on said liquid of said vapors throughout their course to and while undergoing condensation, and releasing from time to time accumulations of gas from the products of condensation.

WILLIAM M. BURTON.

In presence of—
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3154

G. H. GILLONS.

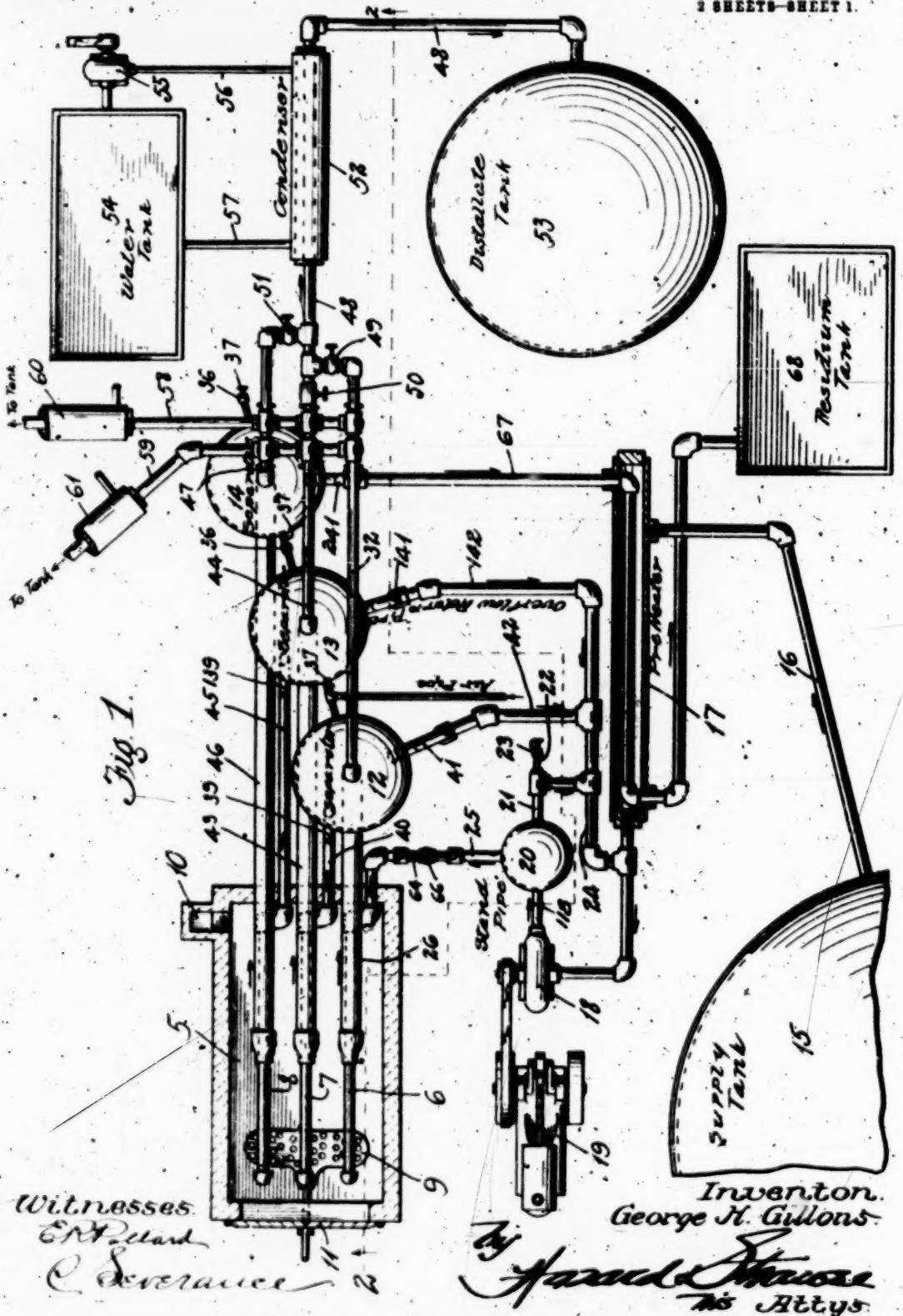
OIL REFINING MECHANISM.

APPLICATION FILED OCT. 30, 1911.

1,084,080.

Patented Jan. 13, 1914.

2 SHEETS—SHEET 1.



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3156

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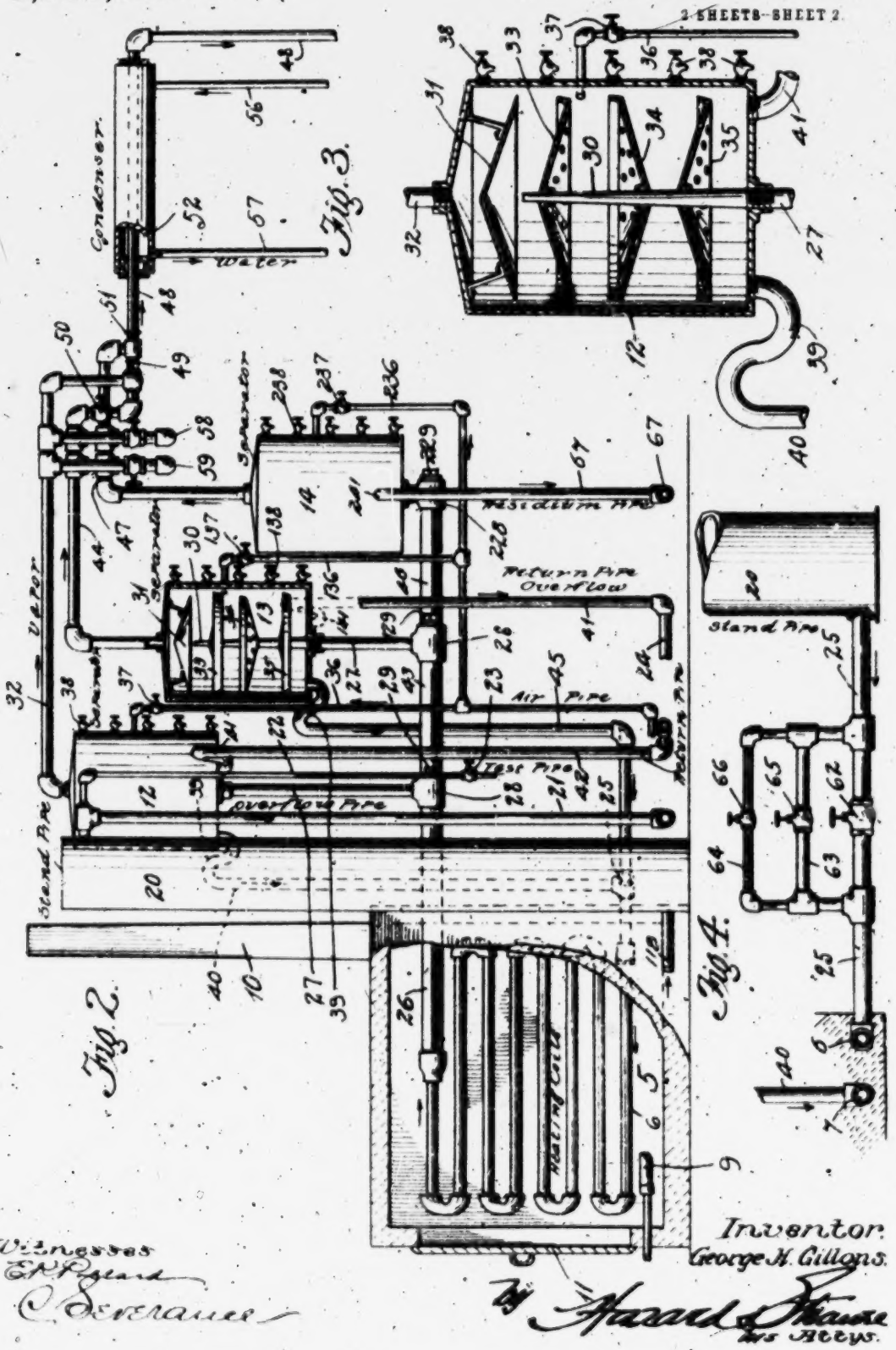
OIL REFINING MECHANISM.

APPLICATION FILED OCT. 30, 1911

1,084,080.

Patented Jan. 13, 1914.

2 SHEETS—SHEET 2.



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UNITED STATES PATENT OFFICE.

GEORGE H. GILLONS, OF LOS ANGELES, CALIFORNIA, ASSIGNOR TO RICHFIELD OIL COMPANY, OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA.

OIL-REFINING MECHANISM.

1,084,080. Specification of Letters Patent. Patented Jan. 13, 1914.

Application filed October 30, 1911. Serial No. 657,472.

To all whom it may concern:

Be it known that I, GEORGE H. GILLONS, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Oil-Refining Mechanism, of which the following is a specification.

This invention relates to improvements in oil refining apparatus, and it is an object of the invention to provide an apparatus in which the oils to be refined may be thoroughly broken up and then subjected repeatedly to the action of heat, whereby an early driving off of distillates of varying degrees of purity may be attained.

It is an object of the invention also to provide an apparatus in which a device is employed capable of thoroughly breaking up and separating the oils to be refined, after they have been given a preliminary heating, the portions which are not driven off in vapor being returned and further heated.

It is a further object of the invention to provide a mechanism in which a number of separating devices adapted to break up the oil and facilitate its being driven off in vapor form may be employed, heating coils cooperating therewith being provided for successively heating portions of the oil which are not immediately driven off in vapor form.

It is also an object of the invention to provide an apparatus in which the oil to be separated may be maintained at a given height in a stand pipe whereby the oil will be fed through the refining mechanism under an even pressure, the said apparatus being adapted to successively heat the oil and also pass the same successively through separating devices.

In the accompanying drawing forming a part of this specification, Figure 1 is a top plan view of a refining apparatus embodying the features of the present invention, portions thereof being shown in section to more clearly disclose the arrangement of the parts. Fig. 2 is a vertical sectional view taken upon the line 2—2 of Fig. 1, parts of the mechanism being shown in side elevation. Fig. 3 is a vertical central sectional view upon an enlarged scale taken through one of the separating devices of the apparatus. Fig. 4 is a detail view in side elevation of a manifold pipe device for controlling the quantity of oil flowing to the heating apparatus from the stand pipe.

The details and features of the invention will now be more particularly described, reference being had to the said drawing, in which—

5 indicates a furnace which may be of any usual or ordinary construction and which is especially adapted to receive a number of coils as 6, 7 and 8 through which the oil to be refined may be successively passed. A burner 9 is mounted in the furnace 5 in such position as to properly heat the coils, and a stack or chimney 10 is provided for the furnace near one end thereof. Access is had to the interior of the furnace through a door 11 usually mounted upon the outer end of the furnace. Of course it will be understood that fuel not requiring a burner may be used in the furnace without departing from the spirit of the invention, it being merely intended to provide a proper and effective heating means for raising the temperature of the oil to a proper extent. Connected with the coils 6, 7, and 8 are separators 12, 13 and 14 which are preferably arranged outside the furnace and in such position with respect thereto that each one can be reached separately and can be operated separately or in conjunction with the others as preferred.

The construction of the separators which are substantially similar forms an important feature of the invention and will be hereinafter more fully described.

The oil is usually supplied to the apparatus from any suitable tank 15 and piping 16 leading the crude oil therefrom delivers the same into a jacket 17 which surrounds the final outlet or residuum pipe of the apparatus so that the heat therefrom will raise the temperature of the inflowing oil to a considerable extent. The oil passes from the jacket 17 to a pump 18 which may be of any desired or ordinary type and driven by an engine 19 or a motor of any kind. The pump drives the oil through pipe 118 into a stand pipe 20 which is of such a height as to cause the oil to flow under the action of gravity, through every part of the apparatus as may be required. The oil is maintained in the stand pipe 20 at a given height by means of an over-flow pipe 21 which leaves the tank at the height at which it is

desired to maintain the oil therein. A small test pipe 22 is provided leading from the pipe 21 and having a controlling valve 23 mounted therein so that the stand pipe may be tested from time to time to see whether oil is standing in the same at the required height. The pipe 21 leads the overflow from the stand pipe 20 through suitable piping 24 and back into the piping upon the suction side of the pump 18 as will be clearly understood by reference to Fig. 1. The pump may thus be caused to always maintain the oil at the right height in the stand pipe with a slight over-flow which will merely be returned to the pump again with the incoming supply of oil.

From the stand pipe 20 the oil is led through pipe 25 to the furnace 5 and into the first coil 6 arranged therein. From the coil 6 the heated oil passes through an enlarged pipe 26 to the first separator 12, the said pipe 26 leading to a point beneath the same from which a branch pipe 27 extends upwardly and into the bottom of the said separator 12. A T-coupling 28 is provided at the end of the pipe 26 and closed by means of a plug 29 so that the said pipe may be cleaned interiorly at any time in the event of the collection of obstructing materials within the same. The said pipe 27 has an elongated tapering projection or nozzle 30 extending upwardly through the central part of the separator 12 to a point near the top thereof as clearly shown in Figs. 2 and 3. A baffle plate 31, preferably conical in shape, is suspended within the separator above the open end of the nozzle so that as the oils are ejected from the nozzle and strike the said plate they will be broken up and separated or sprayed in all directions within the casing of the separator. Fumes or vapors from the oil can then pass around the outer edge of the baffle plate 31 into the top of the casing and find an outlet through a pipe 32 which extends from the top of the said separator 12. The portion of the oil which still remains in a liquefied condition will drop upon a succession of perforated plates 33, 34, and 35 which are mounted within the separator and usually supported upon the nozzle 30.

The perforated plates just referred to are preferably conical in shape and formed with peripheral edges which cause the oil to tend to go through the perforations first though an excess upon the plate will be allowed to run over the edge thereof. The dropping of the oil from one plate to the other tends to further break up and vaporize the same, and also tends to render the oil more susceptible to the refining action of the heat when the liquid portion thereof is returned to the next heating coil. The intermediate plate 34 is preferably reversed in position and shape with respect to the upper and lower plates 33 and 35 as will be clearly understood by reference to Fig. 3 of the drawing so that the oils must pass through the perforations of the plate 34 in order to drop onto the plate 35.

An air pipe 36 is provided for the separator preferably entering the same about half way of its height, the said pipe 36 being also provided with a controlling valve 37. The action of the separator and the driving off of the fumes or vapors produced therein are facilitated by the introduction of air under pressure between the liquid part of the oil, which collects in the bottom of the separator and the fumes or vapors which collect at the top thereof, the air tending to very quickly and thoroughly drive off the vapors through the pipe 32. The separator is also provided with a series of draw off cocks 38 of any desired type which are tapped into the wall of the separator at different heights as clearly shown in Fig. 3. By the use of any one of these draw off cocks the condition of the contents of the separator may be determined at any time.

The liquid portions of the materials in the separator will pass out through a goose neck 39 leading from the bottom of the separator, the goose neck rising to such a height above the bottom thereof as to maintain the liquid at a given height between the bottom of the said separator and the lower plate 35 thereof. From the goose neck the oil is led through piping 40 back to the furnace and into the next heating coil as for instance the coil 7. In the event of the oil accumulating too rapidly in the separator 12, a second outlet with a goose neck 41 is provided which latter goose neck extends to a higher level than the goose neck 39. Thus normally, oil will pass from the separator through the goose neck 39 and the piping 40. In the event, however, of the oil rising unusually high in the separator, it will pass out through the goose neck 41 and through piping 42 to the piping 24 whereby it will be returned to the pump 18 again and introduced into the stand pipe 20 anew.

The description of the separator 12 sets forth the structure of the other separators 13 and 14 also, and the particular construction of said separators 13 and 14 need not therefore be further enlarged upon, it being merely necessary to indicate that the oil returned from the separator 12 will be passed through the heating coil 7 for further heating, and thence through an enlarged pipe 43 to the bottom of the second tank 13 whence it enters the said separator through the same form of mechanism as above described, with respect to the separator 12. The said separator 13 is provided with an outlet pipe 44 for the outlet of the vapors from said separator. The liquid

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portions of the oil from the said separator 13 are adapted to be conducted through a pipe 45 similar to the pipe 40 and provided with a goose neck 139 in the same manner as described with respect to the said pipe 40, the oil thus being led into the heating coil 8. Oil rising above the level of the goose neck 139 will pass through goose neck 141—pipe 142 to pipe 24—as from separator 12. Valves 137 and 138 perform same function as valves 37 and 38 to separator 12. From the said heating coil 8, the oil passes through an enlarged pipe 46 to the bottom of the separator 14, from which it escapes through the nozzle within the separator to be broken up and distributed as already described with respect to the separator 12. The vapors from the said separator 14 find an outlet at the top thereof through a pipe 47, the residuum escaping through neck 241 to pipe 67. The oil may thus be repeatedly heated and separated in the coils and separators successively as above set forth.

The continual passage of the materials through the separators and the heating coils makes it possible to obtain vapors of different degrees of purity so that products of different standards may be separated and collected.

It will also be understood that a greater or less number of separators and coils may be employed within the spirit of the invention, and in fact the apparatus will accomplish the separation of the oil products in a more or less pure condition with merely one of such separators as 12. It is far preferable however to use a plurality of separators, say two, three or more since distillates of far higher percentages of purity may be thus readily obtained. The said tanks have their vapor outlet pipes connected with a suitable manifold system of piping, so that the vapor products from one or more of them, may be separated and led into one collecting reservoir or another as found desirable or each one may be led into a different collecting reservoir, or all of them may be directed into a final reservoir after the oil products have been successively passed through all of the separators and heating coils. Thus it will be observed by reference to Fig. 1 that the vapors from all of the pipes 32, 44 and 47 may if desired be led into a pipe 48, valves 49, 50 and 51 being provided for permitting of the entrance of the ingredients from said pipes to the said pipe 48.

The products from the separators when collected and directed into the pipe 48 are preferably condensed therein by means of a cooling jacket 52 through which the said pipe 48 passes on its way to the collecting tank or reservoir 53. The said jacket is maintained in cooled condition by passing cold water through the same from a tank 54, an ordinary pump 55 being employed for the purpose. The said pump 55 operated in any desired manner draws the water from the tank 54 and forces it through a pipe 56 into and through the said jacket 52, the water returning from the jacket to the said tank 54 and through a pipe 57. Similar valve controlling connections are made between each of the pipes 32, 44 and 47 with piping 58 and 59 which lead through cooling jackets 60 and 61 and thence into other collecting tanks not shown. The vapors may thus be directed from any or all of the said separator discharge pipes, into any one of the collecting tanks or a separate collecting tank may be used entirely and exclusively for any one of the said separators or the products may be grouped in coming from the different separators so that the products from two of them may be led into one tank and from the other into another tank. It will be understood of course that the system of distribution of the products from the separators may be further elaborated within the spirit of the invention.

In supplying the oils to be separated and purified from the stand pipe to the coils and separators, the amount of oil flowing to the system is controlled by a simple expedient and an arrangement of by-pass pipes as shown in Fig. 4. The pipe 25 is provided with a valve 62 and by-pass pipes 63 and 64 with controlling valves 65 and 66 respectively. The pipes 63 and 64 are connected to the pipe 25 on either side of the valve 62, so that the oil may be led around the valve 62 when a reduced flow of oil is required. The pipe 63 is of less diameter than the pipe 25 and the pipe 64 is of less diameter than the pipe 63. It will be readily understood that by a manipulation of the valves 62, 65, and 66 the oil may be forced to pass through any one of the pipes 25, 63 or 64 in accordance with the quantity of oil flow required to the furnace.

After the oils have been reduced to the desired extent the residuum or remaining products are led from the final separator through the goose neck 241 to pipe 67 which extends through the jacket 17 to a residuum tank 68. The heat from the residuum will thus be utilized in warming the inflow of crude oil from the tank 15 to the pump 18 as heretofore referred to.

The operation of the device, it is believed, will be fully understood in connection with the above description since it has been particularly brought out with reference to each of the parts described, and it will be understood that oil in crude form may be maintained at a desired height in the stand pipe 20 and can be fed through some or all of the heating coils in the furnace and pass through some or all of the separators for breaking up the oil and driving off the va-

pors therefrom which are afterward condensed and collected in the tanks provided therefor. It will also be understood that by successively breaking up the oil and heating it, a very refined product may be obtained and that by taking the products from the different tanks, oil products or distillates of varying degrees of purity may be attained.

In the use of this mechanism it is also found that it is possible to treat oil even when a considerable percentage of water or moisture is present therein. This has been difficult to accomplish in other methods of purifying crude oils, it being usually necessary to treat the oil when there is not more than one per cent. of moisture present. In actual use the apparatus of the present invention has already been found capable of thoroughly accomplishing its work when any percentage of water was present in the oil. The employment of the T-couplings 28 affords a ready access to the interior of the enlarged pipes 26, 43, and 46 in which some impurities collect from time to time due to the heating of the oils in the coils and the said pipes may readily be cleansed.

What I claim is:—

1. An apparatus for refining oils, comprising a series of heating coils adapted to successively receive a continuous flow of liquid oil for heating, separating devices adapted to break up and separate the liquid oil from its vapors, the oil being passed through one of said separating devices before delivering the same to each successive heating coil, and means for delivering the vapors from said separators to suitable collecting mechanism.

2. An apparatus for refining oil comprising a furnace having a series of heating coils mounted therein, separators outside the furnace but receiving the oil in its passage between each of the said heating coils, said separators having nozzles therein, and distributing baffle plates for thoroughly breaking up the oil and separating it from its vapors, piping for leading the vapors to any suitable point for collection, and a standpipe extending higher than any of the separating and heating devices, whereby the oil to be refined will be fed to the mechanism under a uniform pressure.

3. An oil refining mechanism comprising a heating device, coils of piping arranged therein, separators mounted outside the heating devices and having connection with the said coils, a feed stand pipe for regulating the pressure at which the oil is delivered to the heating and separating mechanism, a pump for delivering the crude oil into the stand pipe and maintaining it at the desired level therein, an over-flow pipe leading from the stand pipe back to the pump whereby any excess of liquid in the stand pipe will be returned to the circulating system, means for controlling the quantity of oil flow from the stand pipe to the heating devices, and means for collecting the vapors and residuum from the separating tanks.

4. An oil refining mechanism comprising heating coils, a furnace inclosing the same, means for delivering the oil to be refined to said coils in succession, separators interposed in the connections between the coils, and having interiorly arranged nozzles, baffle plates for receiving the oil from the nozzles and spreading the same in the separators, perforated plates also mounted in the said separators and adpted to further break up and distribute the oil and permit vapors to escape therefrom, piping for leading the vapors from said separators, piping for leading the liquid oil back to the furnace, having a goose neck connection for controlling the height of the oil in each separator, each of said separators also having an overflow pipe with a higher goose neck for returning an excessive amount of oil from the separators to the supply system of the apparatus.

5. An oil refining apparatus comprising a furnace, heating coils mounted therein, separators mounted outside the furnace, enlarged piping interposed between each coil and its respective separator, removable plugs for permitting access to said enlarged piping for cleaning the same, piping leading from each of the separators for conducting vapors, therefrom, condensers for cooling the said piping and reducing the vapors to liquefied form again, and means for receiving and holding the said materials thus purified.

6. A refining apparatus comprising a furnace, heating coils mounted therein, separators interposed in the piping between said coils, and having means therein for breaking up and facilitating the separation of vapors from liquid oil, means for introducing air under pressure into said separators so as to lift the vapors from the oils and facilitate the driving off of the said vapors, and collection tanks for receiving the vapors from the said separators.

7. An oil refining apparatus comprising a heater, coils mounted therein, separators associated with the coils, means for driving the oil through a coil first and thence into a separator, and thence into another coil and another separator in succession, piping for delivering the oil vapors from said separators, tanks for receiving the same, a manifolding piping having valves controlling the same for delivering the products separately from each separator to each tank or collectively from all the separators to one tank or from part of the separators to some of the tanks and part to others.

8. An oil refining apparatus comprising a heating furnace, coils therein, separators

coöperating with each of said coils and adapted to receive the oil successively, a pumping mechanism for delivering crude oil to the coils and separators, a crude oil supply having piping leading to said pump, a jacket forming a part of said piping and a residuum outlet pipe leading from the system and passing through said jacket whereby the heat from the residuum will produce an initial heating of the oil before it enters the coils of the furnace.

9. A refining apparatus for oil comprising a heating furnace, coils mounted therein, separators associated with said coils, a stand pipe for delivering oil at a given pressure to the coils and separators, piping leading from said stand pipe to said mechanism having a valve controlling the same, by-pass pipes of different diameters connecting the said piping on opposite sides of said valve, and valves in said by-pass pipes, the adjustment of the valves controlling the quantity of oil flow delivered from the stand pipe to the refining apparatus.

In witness that I claim the foregoing I have hereunto subscribed my name this 18th day of Oct., 1911.

GEORGE H. GILLONS.

Witnesses:
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EARLE R. POLLARD.

3164

W. M. BURTON.

MANUFACTURE OF GASOLENE.

APPLICATION FILED AUG. 25, 1913. RENEWED MAY 25, 1914.

1,105,961. Patented Aug. 4, 1914.

2 SHEETS—SHEET 1.

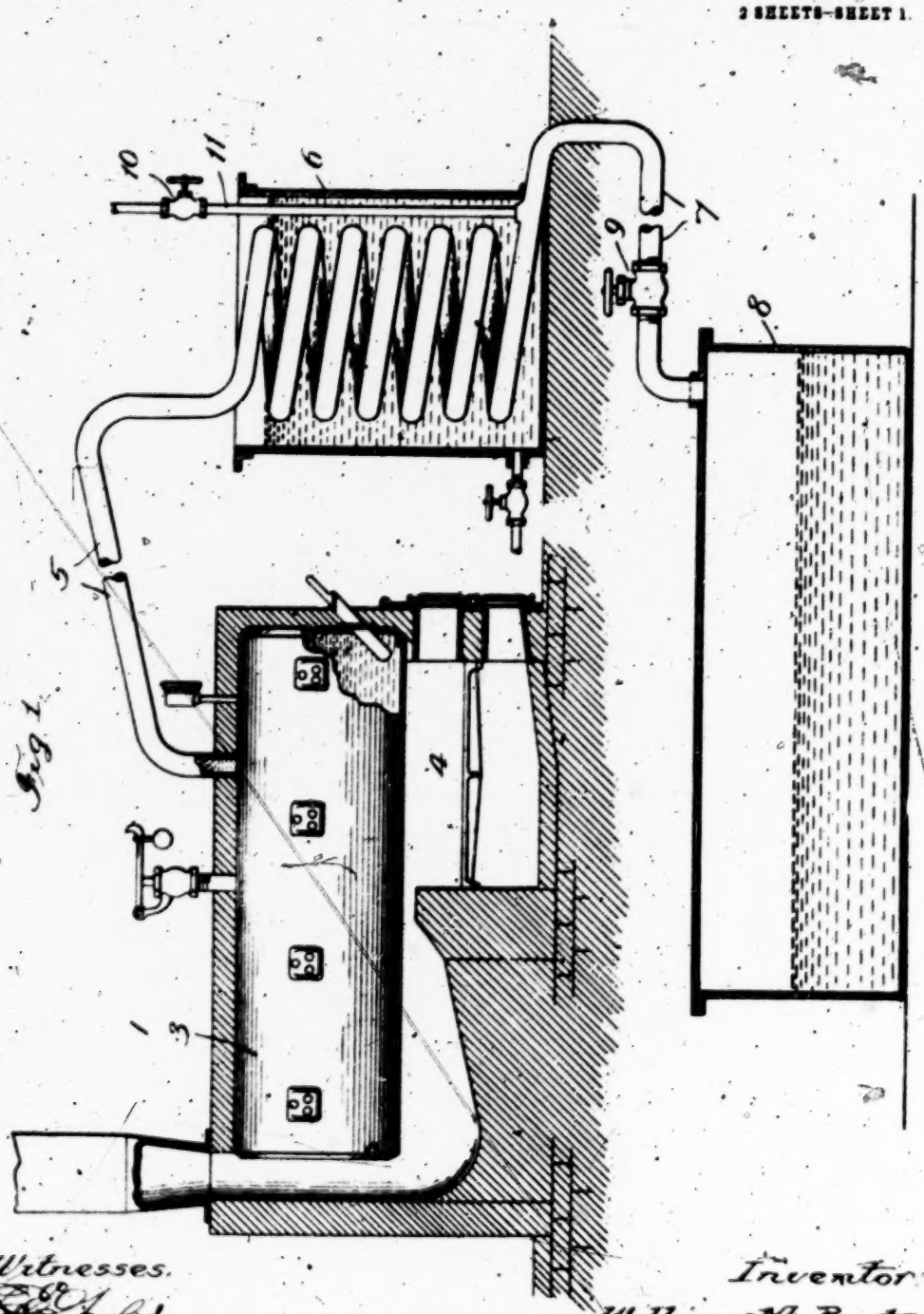

Fig. 1.

Witnesses.
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Chas. H. Burell

Inventor.
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By Dyrenforth Lee Chrisman & Wilkins
Attys.

3166

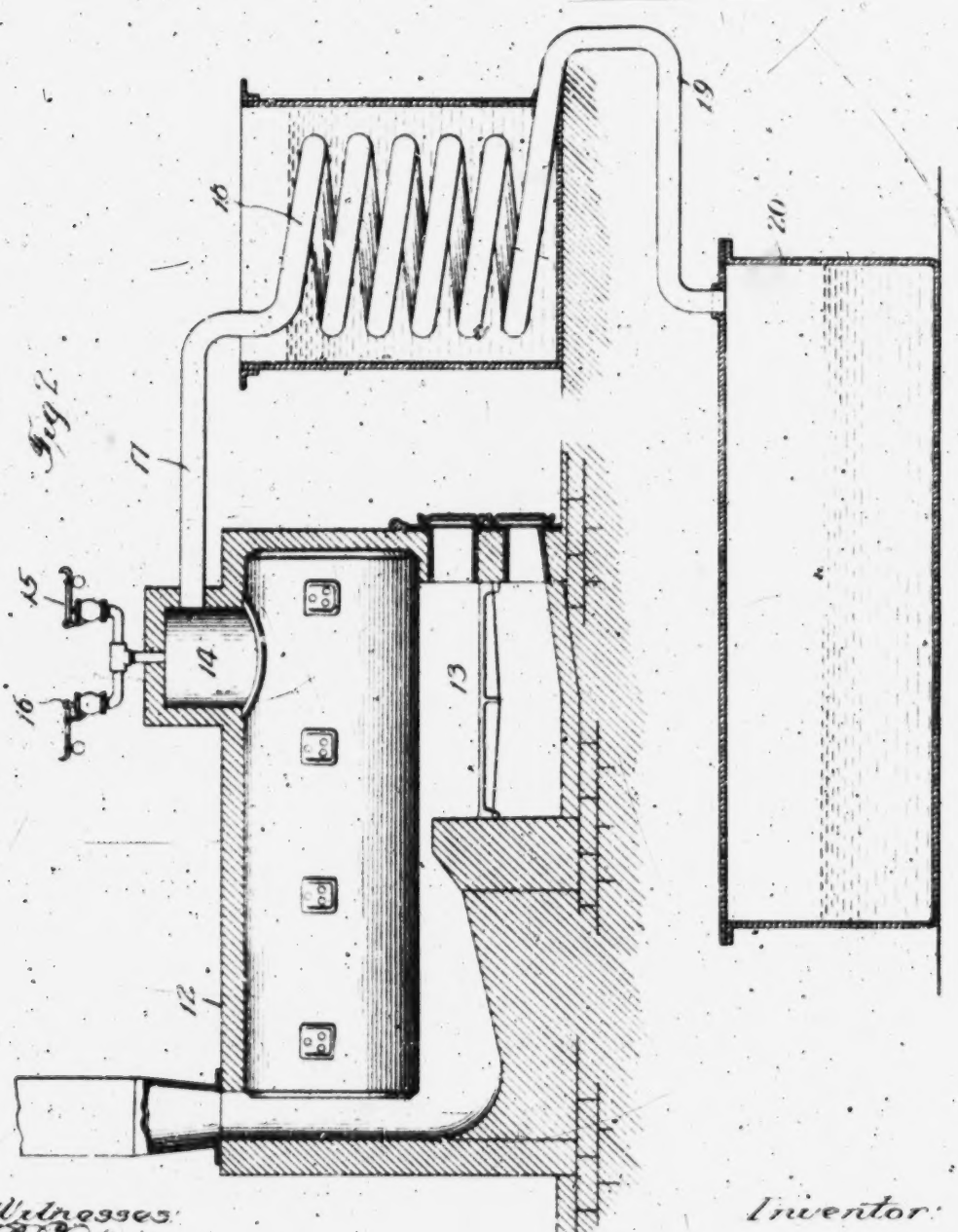
W. M. BURTON.

MANUFACTURE OF GASOLENE.

APPLICATION FILED AUG. 25, 1913. RENEWED MAY 2[illegible], 1914.

1,105,961. Patented Aug. 4, 1914.

2 SHEETS SHEET 2.



Witnesses:
[illegible] Seybold.
Chas. H. Bull.

Inventor:
William M. Burton.
By Dyrenforth, Lee, Chritton & Wilkinson
Attys.

UNITED STATES PATENT OFFICE.

WILLIAM M. BURTON, OF CHICAGO, ILLINOIS, ASSIGNOR TO STANDARD OIL COMPANY, OF WHITING, INDIANA, A CORPORATION OF INDIANA.

MANUFACTURE OF GASOLENE.

1,105,961. Specification of Letters Patent. Patented Aug. 4, 1914.

Application filed August 25, 1913, Serial No. 786,456. Renewed May 25, 1914. Serial No. 840,959.

To all whom it may concern:

Be it known that I, WILLIAM M. BURTON, a citizen of the United States, residing at Chicago, in the county of Cook and State of Illinois, have invented a new and useful Improvement in the Manufacture of Gasolene, of which the following is a specification.

The present invention relates to an improvement upon the method of manufacturing low boiling point products of petroleum-distillation set forth in United States Letters Patent No. 1,049,667, granted to me January 7, 1913; and it is in the nature of an extension of that method, to the end of greatly increasing, by the practice thereof, the production of these products from a given quantity of fuel-oil or other high-boiling-point product of petroleum distillation.

Apparatus suitable for the practice of my improved method is illustrated in the accompanying drawings, in which—

Figure 1 is a broken view in vertical longitudinal section, diagrammatic in character, showing the parts in elevation of the first still and its accessories, and Fig. 2 is a similar view of the second still.

The apparatus illustrated in Fig. 1 is that shown in the aforesaid patent, according to the method of which a supply is introduced into the still 3 of the residual liquid-portion of the paraffin-series of petroleum-distillation—say, the distillate known as fuel-oil—having a boiling point upward of 500° F., and is subjected to a temperature from the furnace 4, of about 650° F. to about 850° F. to distil its volatile constituents, which are conducted off by a pipe 5 through a condenser 6, the coil of which discharges through a pipe-extension 7 into a receiver 8 for the products of condensation. In this pipe-extension, and thus beyond the discharge-end of the coil, is contained a normally-closed shut-off valve 9 for maintaining a pressure of from about 4 to 5 atmospheres on the liquid in the still of the vapors throughout their course to and through the condenser; and this pressure of the vapors combined with their contained heat converts the high boiling point members of the paraffin series into low boiling point members of the same series. This method of distillation is continued until the residue in the still is reduced to a thin syrup-like consistency, and the original charge has been reduced to from 30 to 40 per cent. of its bulk. In the meantime, it is desirable to open, from time to time, a relief-valve 10 in the upper end of a pipe 11 rising from near the lower end of the condenser-coil, for relieving the gas-pressure, which is liable to accumulate in the coil and obstruct the action of the apparatus.

It is at this point that my present improvement begins: The residue is withdrawn from the still 3 and is introduced into a second still 12, heated by a furnace 13 and provided with a vapor-dome 14 equipped with a pressure safety-valve 15 and a vacuum safety-valve 16, both of which are of well-known construction and manner of operation, and need not, therefore, be shown nor described in detail. A pipe 17 connects the vapor-dome with a condenser-coil 18, discharging from its lower end through an extension 19 into a receiver 20.

The contents of the still are maintained under atmospheric or approximately atmospheric pressure thereon while under subjection to heat from the furnace 13, to distil the volatile constituents of said contents, which are conducted off through the pipe 17 and condensed in the condenser; and the products of condensation accumulate as a yellowish liquid in the receiver 20. This procedure is carried on until the original contents of the still 12 have been reduced to a condition of dryness, the distillate accumulated in the receiver 20 amounting to about 95 per cent. of the charge in the still 12.

The liquid of condensation in the receiver 20 is withdrawn therefrom and introduced into the still 3, or into another like it for separate treatment, and is there subjected to the original process described as being practised therein; and the resultant distillate is a low boiling point product, belonging to the paraffin series, the same as the second petroleum residue from which it was distilled. It is my practice, and the preferable one, instead of treating the contents of the receiver 20 separately in a still 3, as suggested, to mix them with original residue treated therein; though the result is the same in either case. By following the last-named practice, about 63½ per cent. of the original charge in still 3 is converted into gasolene, about 1½ per cent. going off in the form of gas, which I use as fuel for heat-

ing that still. This leaves somewhat less than 35 per cent. of the original charge as residue to be treated in still 12, from which about 95 per cent. is distilled, leaving about 5 per cent. as dry residue or coke; and this distillate being turned back into still 3 for treatment with the charge introduced therein for the original treatment again produces in the first still the same yields of about 63½ per cent. of gasolene and about 35 per cent. of residue. In this way the practice may be carried on endlessly, by the addition of fresh charges into the high-pressure still 3.

I thus succeed in converting practically all (not considering the incidental losses) of the original high boiling point product first treated by the process practised in still 3 with its described accessories, into a superior article of gasolene of the same paraffin series or group as that of the aforesaid original residue.

It will, of course, be understood by those skilled in the art, that the low boiling point product herein referred to as gasolene, is crude gasolene, which has to be prepared for the market by first treating it with strong sulfuric acid and then re-distilled to produce the finished deodorized gasolene, and that the sulfuric-acid treatment entails a loss of about 1¼ per cent.; also the so-called "bottoms" are left over from the re-distillation. However, it is my practice to introduce these bottoms into the still 3 and mix them with the materials treated therein.

What I claim as new and desire to secure by Letters Patent is—

1. The method of treating the liquid-portions of the paraffin-series of petroleum-distillation having a boiling point of upward of 500° F. to obtain therefrom low-boiling-point products of the same series, which consists in distilling at a temperature of from about 650° F. to about 850° F. the volatile constituents of said liquid, conducting off and condensing said constituents, and maintaining a pressure of from about 4 to about 5 atmospheres on said liquid of said vapors distilling under approximately atmospheric pressure the volatile constituents of the residue of said first distillation and conducting off and condensing said last-named constituents, and finally subjecting the last product of condensation to the first-named treatment.

2. The method of treating the liquid-portions of the paraffin-series of petroleum-distillation having a boiling point of upward of 500° F. to obtain therefrom low-boiling-point products of the same series, which consists in distilling at a temperature of from about 650° F. to about 850° F. the volatile constituents of said liquid, conducting off and condensing said constituents, and maintaining a pressure of from about 4 to about 5 atmospheres on said liquid of said vapors throughout their course to and while undergoing condensation, distilling under approximately atmospheric temperature the volatile constituents of the residue of said first distillation and conducting off and condensing said last-named constituents, mixing this distillate with more of said liquid and subjecting it therewith to said first-named treatment.

WILLIAM M. BURTON.

In presence of—
L. HOLZHALB,
O. C. AVISUS.

3170

R. E. HUMPHREYS.

METHOD OF DISTILLING HYDROCARBONS.

APPLICATION FILED JUNE 26, 1914.

1,119,700.

Patented Dec. 1, 1914.

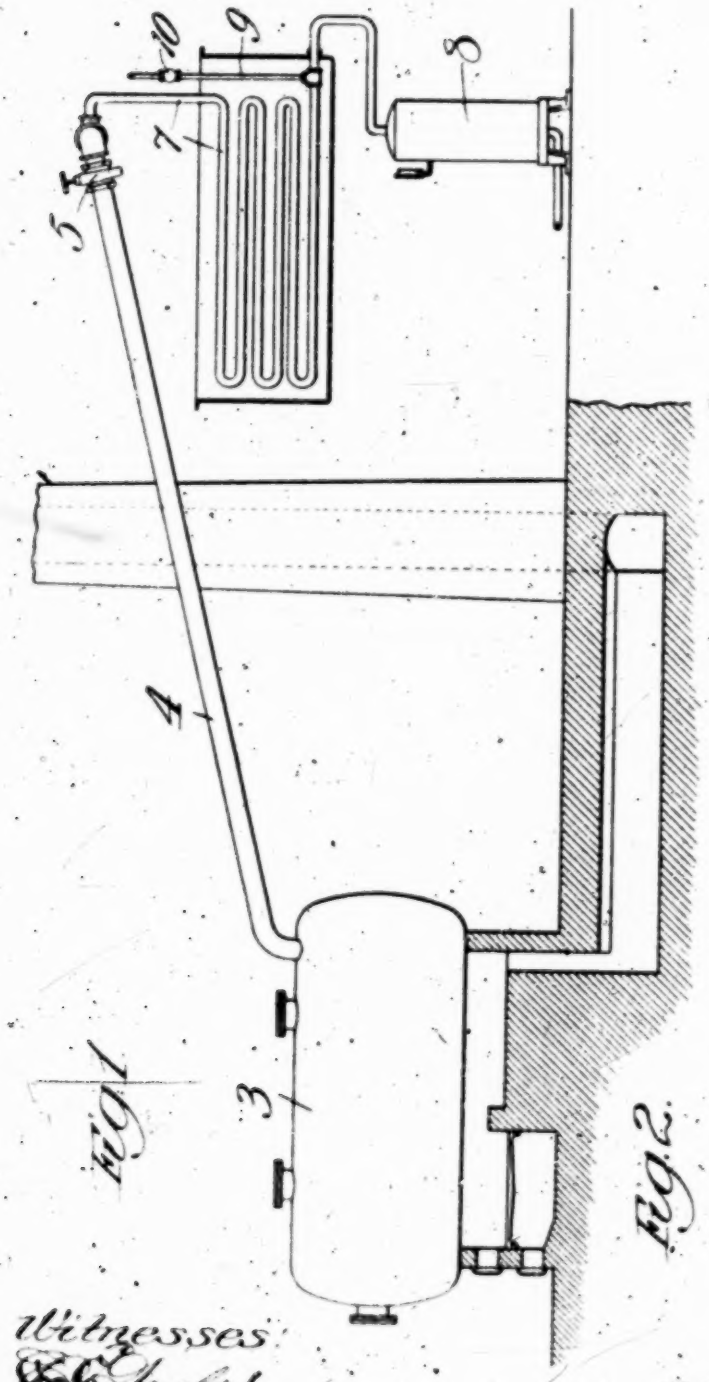


Fig. 1.

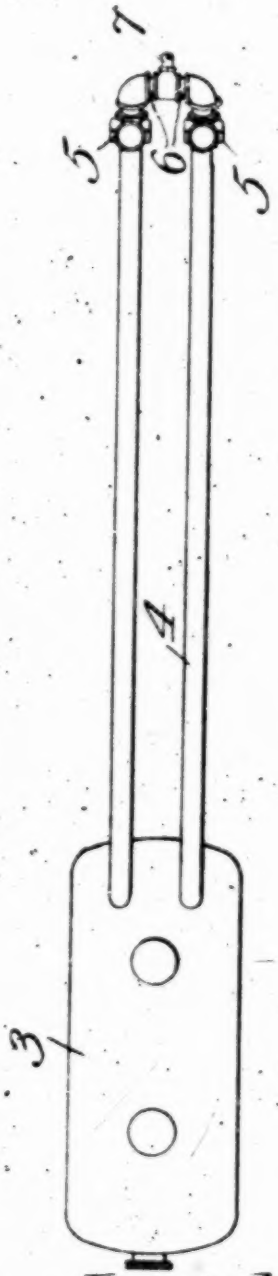


Fig. 2.

Witnesses:

Inventor:
Robert E. Humphreys
By Dyrenforth Lee Chritton & Wallace
Attys.

UNITED STATES PATENT OFFICE.

ROBERT E. HUMPHREYS, OF WHITING, INDIANA, ASSIGNOR TO STANDARD OIL COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF INDIANA.

METHOD OF DISTILLING HYDROCARBONS.

1,119,700. Specification of Letters Patent. Patented Dec. 1, 1914.

Application filed June 26, 1914. Serial No. 847,412.

To all whom it may concern:

Be it known that I, ROBERT E. HUMPHREYS, a citizen of the United States, residing at Whiting, in the county of Lake and State of Indiana, have invented a new and useful Improvement in the Method of Distilling Hydrocarbons, of which the following is a specification.

My invention consists in a novel method for the distillation of hydrocarbons, its object being primarily so to treat hydrocarbons of relatively high boiling-point (such, for example, as the product known in the trade as fuel-oil, a paraffin oil, the boiling point of which is upward of 500° F.), as to produce therefrom hydrocarbons of much lower boiling-point, such as the commercial product known as gasolene which is a paraffin oil of much lower boiling point.

In the practice of my process, in its preferred form, I employ as measures of commercial expediency, all the devices and processes which have been found useful for that purpose. Among these processes and devices may be mentioned the process of the Burton Patent No. 1,049,667, dated January 7, 1913, and the process of my application, Serial No. 813,220, filed January 20, 1914. However desirable these features are in practice, they form no part of my present invention and are, therefore, not here illustrated, but are enumerated in order that those skilled in the art will understand that the highest possible efficiency requires that the present invention be supplemented by what is now the most approved practice in the same general field.

My process is preferably carried out in an apparatus, such as that herein illustrated, in which—

Figure 1 is a side sectional elevation, and Fig. 2 is a top plan of the apparatus, suitable for carrying out the process.

Referring to the drawings, 3 is a still which may be of ordinary form. Extending obliquely upward from the still is a conduit consisting of two pipes 4, side by side, each controlled by a valve 5. The pipes 4 communicate with a header 6 which opens into a condenser 7. The condensed products enter a receiving drum 8, and the uncondensed gases pass out through a relief-pipe 9 controlled by the valve 10.

The valve in the relief-pipe is so manipulated as to maintain in the system a pressure of upward of 4 atmospheres, so that the distillation takes place at the temperature required by the high pressure thus produced. When the raw material is the commercial product known as fuel oil, the temperature will be upward of 650° F. and the distillate entering the receiving drum 8 will be crude gasolene.

The essence of the present invention is the use of the inclined conduit, consisting of the pipes 4, and in practical operation the use of this inclined conduit, or run-back, as it is commonly termed in practice, is most important. Its operation is as follows: The complicated chemical processes going on in the still produce products of varying gravities, and consequently of varying molecular weights and boiling-points. The fractions vary from non-condensable gases, through the light naphthas down to fractions which are but slightly lighter than the raw material. The operation of the inclined conduit, or run-back, is to condense the heavier fractions of the distillate and automatically to return them to the still 3 for further treatment therein. In other words, this inclined conduit has the practical effect of subjecting the heavier fractions repeatedly to the action of the pressure and temperature in the still, until the desired molecular re-arrangement has occurred, while permitting those fractions which have already been sufficiently acted upon to pass over and be condensed. It is manifest, therefore, that the size and dimensions of the inclined conduit, or run-back, is of considerable importance, and I may suggest, by way of example that I have found that in the use of a still 8 ft. in diameter and 20 ft. in length an inclined conduit, or run-back, consisting of two pipes each 12 inches in diameter and 40 ft. long produces a distillate of the proper gravity for crude gasolene. The use of two pipes is advantageous because, when the end of the run approaches and the flow of the vapors is slow, one half the conduit can be closed, so that condensation can be maintained of the proper amount.

While as heretofore stated, I prefer to hold the vapors under pressure throughout their course and while undergoing both the initial and final condensation, as by controlling the relief pipe 9, it is manifest that the pressure control of the final condensation, *i. e.* the condensation of the light va-

pors which pass from the run-back is not essential to the invention. Such fractional condensation as occurs in the run back itself, however, should evidently be under pressure for the carrying out of my process, as otherwise there would be considerable difficulty in returning the condensed fractions to the still for further treatment therein.

I realize that considerable variation is possible in the details of the process herein shown, and I do not intend to limit myself thereto, except as pointed out in the following claims, in which it is my intention to claim all the novelty inherent in the process as broadly as is permitted by the state of the art.

What I claim as new and desire to secure by Letters Patent is:—

1. The method of treating liquid residue of the paraffin series of petroleum distillation having a boiling point of upward of 500° F. to produce therefrom hydrocarbon oils of the same series but of lower boiling points, which consists in distilling the high boiling point hydrocarbons under a pressure of upward of four atmospheres, cooling all the vapors passing from the still while under such pressure to condense the heavier fractions thereof, and simultaneously returning the condensed heavier fractions to the still to undergo therein further treatment, and leading off and condensing the light vapors.

2. The method of treating liquid residue of the paraffin series of petroleum distillation having a boiling point of upward of 500° F. to produce therefrom hydrocarbon oils of the same series but of lower boiling points, which consists in distilling the high boiling point hydrocarbons under a pressure of upward of four atmospheres, cooling all the vapors passing from the still to condense the heavier fractions thereof and simultaneously returning the condensed heavier fractions to the still to undergo therein further treatment and leading off and condensing the light vapors, maintaining such distillation pressure of upward of four atmospheres on said vapors throughout their course to and while undergoing condensation.

In testimony whereof I have hereunto set my hand this 24th day of June, 1914.

ROBERT E. HUMPHREYS.

In the presence of two subscribing witnesses:

A. C. FISCHER,
F. A. FLORELL.

3174

J. A. DUBBS.

TREATING OIL.

APPLICATION FILED NOV. 20, 1909.

1,123,502.

Patented Jan. 5, 1915.

2 SHEETS—SHEET 1.

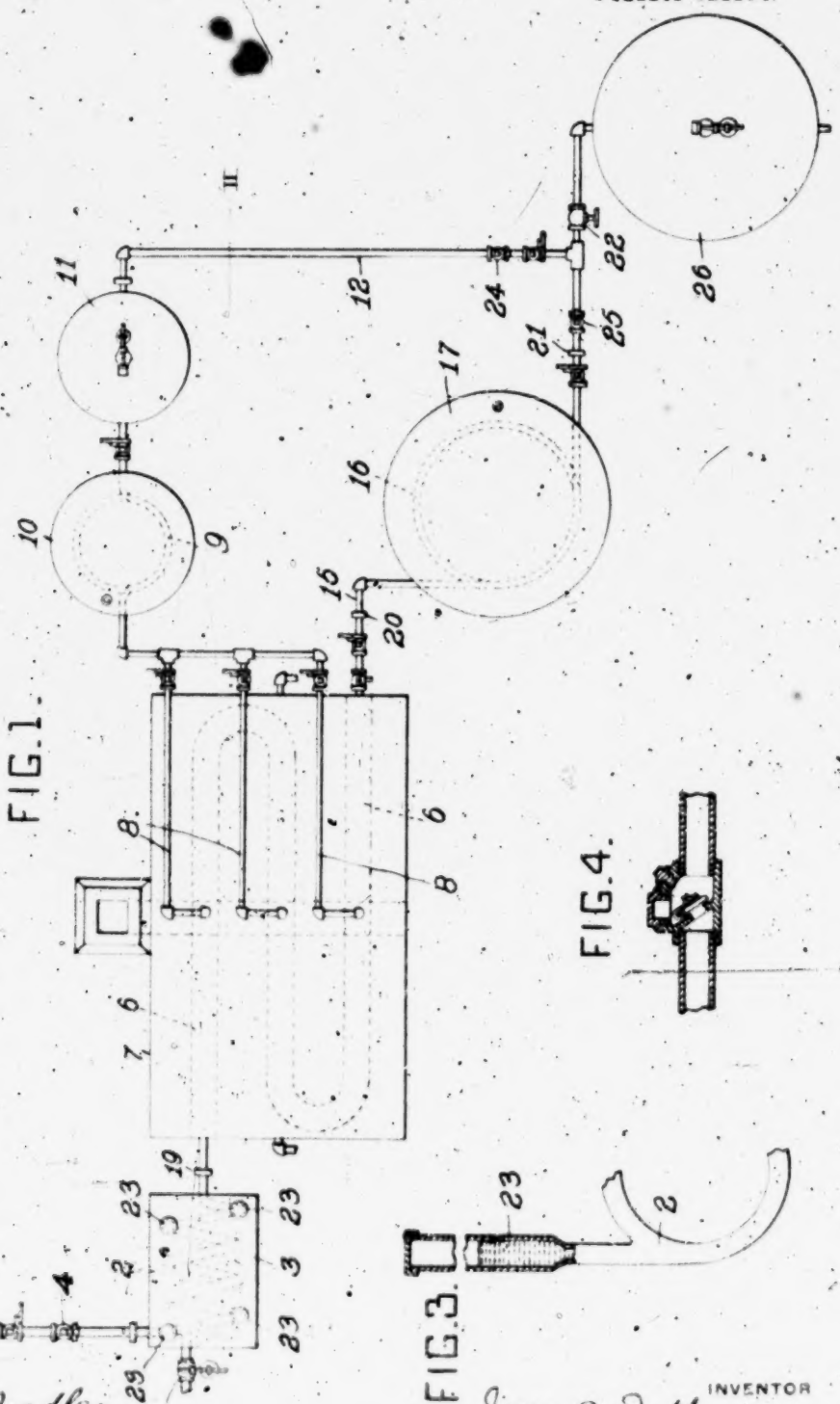


FIG. 1.

FIG. 4.

FIG. 3.

WITNESSES

J. Herbert Bradley

Francis J. Tomasin

INVENTOR

Jesse A. Dubbs

by Christy and Christy

3176

J. A. DUBBS.

TREATING OIL.

APPLICATION FILED NOV. 20, 1909.

1,123,502.

Patented Jan. 5, 1915.

2 SHEETS-SHEET 2.

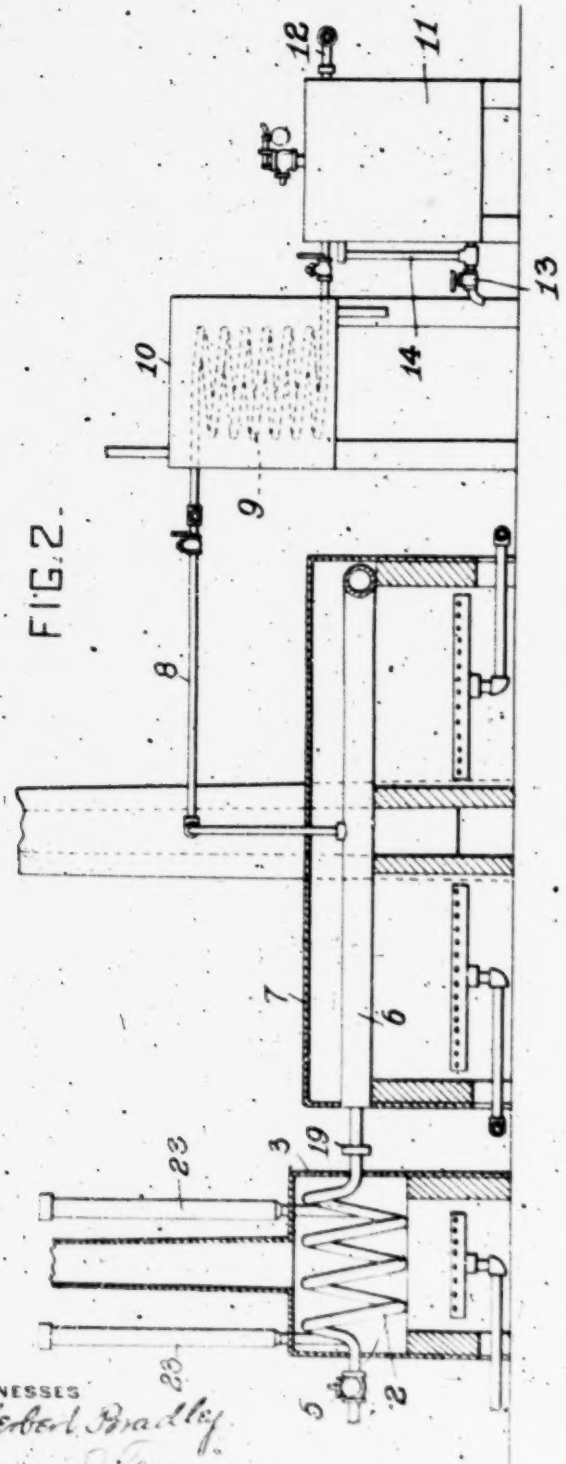


FIG. 2.

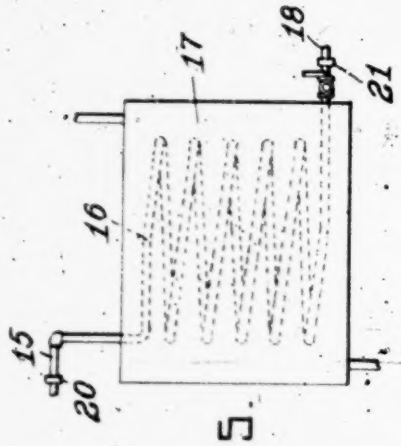


FIG. 5.

WITNESSES

J. Herbert Bradley

Frances J. Timmins

INVENTOR

Jesse A. Dubbs

by Christy and Christy

Atty's

3177

UNITED STATES PATENT OFFICE.

JESSE A. DUBBS, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO NATIONAL HYDROCARBON COMPANY, A CORPORATION OF SOUTH DAKOTA.

TREATING OIL.

1,123,502. Specification of Letters Patent. Patented Jan. 5, 1915.

Application filed November 20, 1909. Serial No. 529,049.

To all whom it may concern:

Be it known that I, JESSE A. DUBBS, a citizen of the United States, residing in the city of Los Angeles, county of Los Angeles, and State of California, have invented certain new and useful Improvements in Treating Oil, of which the following is a specification.

This invention relates to improvements in treating oil and refers more particularly to a process of subjecting the oil to heat and pressure.

Among the salient objects of the invention are to provide an improved method of treating oil wherein both the vaporization and condensation take place under the pressure of the generated vapors; to provide a method which is particularly adapted for the removal of the finely divided particles of water from emulsified hydrocarbon oils; to provide a method which will permit of the oil being continuously subjected to the required heat and pressure in both the still and condenser without the interruption of its flow; to provide a method by which this may be safely and economically done and in general to provide an improved method of the character referred to.

A method of removing the water from emulsified oil is disclosed in Letters Patent No. 890,762 granted to me June 16th, 1908.

The invention consists in the matters hereinafter described and more particularly pointed out in the appended claims.

In the accompanying drawings forming a part of this specification, Figure 1 is a plan view, illustrating a form of apparatus adapted to the practice of my improvement; Fig. 2 is a view in longitudinal section, the plane of section being indicated by the line II—II, Fig. 1; Fig. 3 is a detail view of a stand or cushioning pipe connected with the apparatus; Fig. 4 is a view in longitudinal section of a check valve such as may be employer at several points in the apparatus, as will hereinafter be more fully described; Fig. 5 is a view in side elevation of the main cooling tank; parts which are repeated in the several figures bear the same reference numerals in each case.

In the preferred apparatus for the practice of my invention, the oil is forced from the pipe line leading from the well or other source of supply, through the pipe 1, into the coil 2, which may be heated to the desired temperature by any suitable means, as for example, by arranging the coil in the heating chamber of a suitable furnace, indicated at 3. It is preferred that a check valve 4 (which may be conveniently of the structure indicated in Fig. 4) should be arranged in the pipe 1, to prevent any backward flow of oil, in case of an excessive pressure in the apparatus; and, for the protection of the apparatus, and the operation, a safety valve, indicated at 5, is connected with the coil. From this preliminary heating coil 2, the oil passes into a larger coil 6, which may be heated to the desired temperature in any suitable manner, as by arranging it in the heating chamber of a furnace, indicated at 7. The pipe composing this coil is preferably of larger internal diameter than the pipe of the coil 2, so that there may be a segregation of the steam (produced from the water which the oil contained) and the vapors of the more volatile constituents of the oil from the liquid portions thereof, such segregated gases or vapors being conducted away from the coil by means of distillation pipes 8 to the condensing coil 9, located in a receptacle 10, through which a cooling fluid is caused to flow, condensing the oil and water vapors passing through the coil. From this coil 9 the condensed vapors flow into the separating chamber 11, where the water and the oil are allowed to stratify, in accordance with their relative specific gravities. From this separating chamber 11, the condensed hydrocarbons are carried away by the pipe 12, and the condensed steam is drawn off from time to time through the outlet 13. For convenience in determining the relative amounts of oil and water in the tank 11, a glass tube 14 is connected thereto, preferably through the cock 13, and extends up a suitable height along the tank. From the coil 6 the treated oil (relieved of the substantial part of the burden of water which the untreated oil carried in finely divided particles) flows, by the pipe 15 into a cooling coil 16, arranged in a tank 17, where it may be subjected to the action of a cooling fluid, and from this cooler the oil flows by the pipe 18 to a suitable receptacle 26, where a stratification of the oil and the small amount of water remaining may occur. Such gravity separators are well known to the art, and my invention has nothing to do with the specific construction of this piece of apparatus.

Pyrometers, which may be of ordinary type, and whose positions are indicated at 19, 20 and 21 are provided, one intermediate the preliminary heater and the main heater, another in the outlet pipe 15 from the main heater, and another in the outlet pipe 18 from the cooler. By means of these pyrometers, the operator may ascertain whether he is maintaining the proper temperatures at various points in the apparatus. The pipe 12 leading from the separating tank 11 may conveniently be connected to the outlet pipe 18 from the cooler 17, so that the condensed vapors from the tank 11 or products floating on the water in the tank may mingle with the treated oil on its way from the cooler to the stratifying receptacle 26; in that receptacle, whatever traces of water may remain in the oil flowing in pipe 15 from coil 6, and whatever traces of water may remain in the distilled oil flowing in pipe 12 are practically removed.

In order to maintain the desired pressure within the system, including the condenser 9 and separating chamber 11, a throttle valve 22 of any suitable form or construction may be located in the outlet pipe 18, at a point beyond the connection of the pipe 12 therewith. By properly adjusting this valve 22 to the pressure under which oil enters the apparatus, any required pressure may be maintained. Check valves 24 and 25 (which also may be of the construction indicated in Fig. 4) are preferably introduced in pipes 12 and 18 which lead from separator 11 and from cooler 17.

In order to prevent injury to the apparatus, cushioning means are employed, preferably located at different points in the coil 2 for the preliminary heating of the oil as in such coils the hammer blows would be more apt to originate. These cushioning devices preferably consist of stand pipes 23 of suitable height. The stand pipes may be made of a height greater than that at which the liquid would stand for the pressure in the apparatus, so that in the case of a hammer blow these liquid columns will form a yielding cushion; or, preferably, as indicated in Fig. 3, the stand pipes 23 are closed at the top and a body of inclosed air affords the cushioning effect desired. In treating these emulsion oils the heat and pressure to which the oil is subjected to effect a segregation of the water and oil will be approximately proportional to the manner in which the oil and water are mixed, *i. e.*, whether the globules of water are large or small and also to the percentage of water contained in the oil. If the globules are small, or if the percentage of water is large the heat or pressure or both should be increased. As for example, in oil containing about 28% of water (which is the case of oil of the Santa Maria field of California), a pressure of about 25 pounds, and a temperature of 325° F., more or less, has given very good results, as regards the segregation of the water, although I have performed my operation under pressures ranging from three to two hundred and fifty pounds above atmospheric. As the oil is maintained above the vaporizing point of water, and as an opportunity is afforded in the large coil 6 for a separation of the water vapors, it will be observed that a large percentage of the water will be converted into vapor and condensed together with the vapors of the more volatile constituents of the oil, in the condenser 9. Both the oil and water vapors are condensed simultaneously and then flow into the separator where a gravity separation of the two will occur.

The apparatus is so constructed that the oil may be subjected to the required heat and pressure without interruption of the flow.

I claim as my invention—

1. An improvement in the art of treating emulsified oil consisting in removing from a flowing body of such oil its finely divided particles of water in and by a continuous process which consists in heating the oil in a receptacle from which is excluded at all times an externally obtained pressure medium, and both vaporizing and condensing the vapors under pressure in excess of atmospheric, said pressure being produced by the vapors generated from the oil under treatment.

2. An improvement in the art of treating emulsified hydrocarbon oil containing at least 5% of water, consisting in removing from a continuously supplied body of such oil its finely divided particles of water in and by a continuous process which consists, in submitting successive portions of the oil to a temperature above that required for boiling water at the pressure obtained and condensing the vapors thus produced, both the vaporization and condensation taking place under pressure in excess of atmospheric, such pressure being produced solely by the vapor generated from the oil under treatment.

3. As an improvement in the art of treating emulsion oil, the method, herein described, of removing from a flowing body of such oil its finely divided particles of water, in and by a continuous operation, which consists in submitting the flowing stream to a pressure in excess of atmospheric, submitting such pressure-sustaining portion of the stream to a temperature required for boiling water at such pressure, separating from the flowing stream the distillate so produced, submitting the distillate to a gravity-separating operation, restoring to the main stream the floating product of such gravity-separation, and submitting the

united bodies to a second gravity-separating operation.

4. The method, herein described, of removing from a stream of emulsion oil, as it flows, its finely divided particles of water, such method consisting of subjecting a portion of the flowing stream to a pressure in excess of atmospheric pressure, causing the pressure-sustaining portion of the flowing stream to pass, first through a relatively constricted conductor, and then through a relatively large conductor, raising the temperature of the constricted stream to a point approximating the boiling point of water, bringing the temperature of the enlarged stream to the boiling point of water under such pressure and then successively relieving such stream, first of its excess temperature, and second of its excess pressure, and submitting the oil, as it flows, to a gravity-separating operation.

5. The herein described method of removing the finely divided particles of water from emulsified pitch-yielding hydrocarbon oils, containing five per cent. of water or more, which consists in subjecting a body of such oil to a pressure above atmospheric, producing said pressure by heating said oil to a temperature above that required for boiling water at said pressure, and during said treatment removing the steam and oily vapors generated.

6. The herein described method of removing the finely divided particles of water from emulsified pitch yielding hydrocarbon oil containing at least 5% of water, which consists in subjecting a body of such oil to a pressure above atmospheric, said pressure being produced by heating the oil to a temperature above that required for boiling water at said pressure, permitting the products volatilized from the oil to pass freely to a condenser and subjecting said volatilized products while under their self-imposed pressure to the action of said condenser.

7. The herein described method of removing the finely divided particles of water from emulsified pitch yielding hydrocarbon oil containing at least 5% of water, which consists in subjecting a body of such oil to a pressure above atmospheric, said pressure being produced by heating the oil to a temperature above that required for boiling water at said pressure, permitting the products volatilized from the oil to pass to a condenser, and subjecting said volatilized products while under their self-imposed pressure to the action of said condenser and regulating the pressure exerted by said volatilized products by controlling the discharge from the condenser.

8. The herein described process of treating hydrocarbon oil which consists in subjecting a body of such oil in a receptacle to a pressure materially above atmospheric, said pressure being produced by the products volatilized from the oil under treatment in the heating of the oil to a temperature above that required for vaporizing water at the operating pressure, permitting the generated vapors to pass continuously from said receptacle to a condenser and subjecting such vapors to the action of the condenser while under their self-imposed pressure above atmospheric, unaided at all times by extraneous gaseous pressure.

9. The herein described process of treating hydrocarbon oil which consists in subjecting such oil in a receptacle to a temperature in excess of 300° F., permitting the volatilized products generated from the oil under treatment to pass freely to a condenser where they are condensed, and maintaining substantially the entire pressure exceeding ten pounds to the square inch in both the receptacle and condenser during the whole process solely by the vapors generated from the material under treatment.

10. The herein described process of treating hydrocarbon oil, which consists in subjecting a body of such oil in a receptacle having a space above the liquid to a pressure in excess of atmospheric, obtaining substantially the entire pressure desired by the products volatilized from the oil under treatment by the heating of the oil, substantially the entire space above the liquid in the receptacle being occupied during the whole process solely by said volatilized products, and subjecting said volatilized products while under their self-imposed pressure above atmospheric to a condensing action.

11. An improvement in the art of treating hydrocarbon oil by heating and distilling the products volatilized therefrom under pressure effected by the volatile constituents of said liquid, consisting in supplying the oil to a container, heating it for causing volatilization, confining the volatilized constituents in the presence of the oil for causing a pressure thereon materially exceeding atmospheric, continuously passing the volatilized products to a condenser and effecting condensation thereof under their self-imposed pressure, and controlling the pressure on the oil by regulating the discharge from the condenser.

In testimony whereof, I have hereunto set my hand.

JESSE A. DUBBS.

Witnesses:
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3182

S. H. EDWARDS.

OIL DISTILLING APPARATUS.

APPLICATION FILED MAY 8, 1915.

1,170,884.

Patented Feb. 8, 1916.

3 SHEETS—SHEET 1.

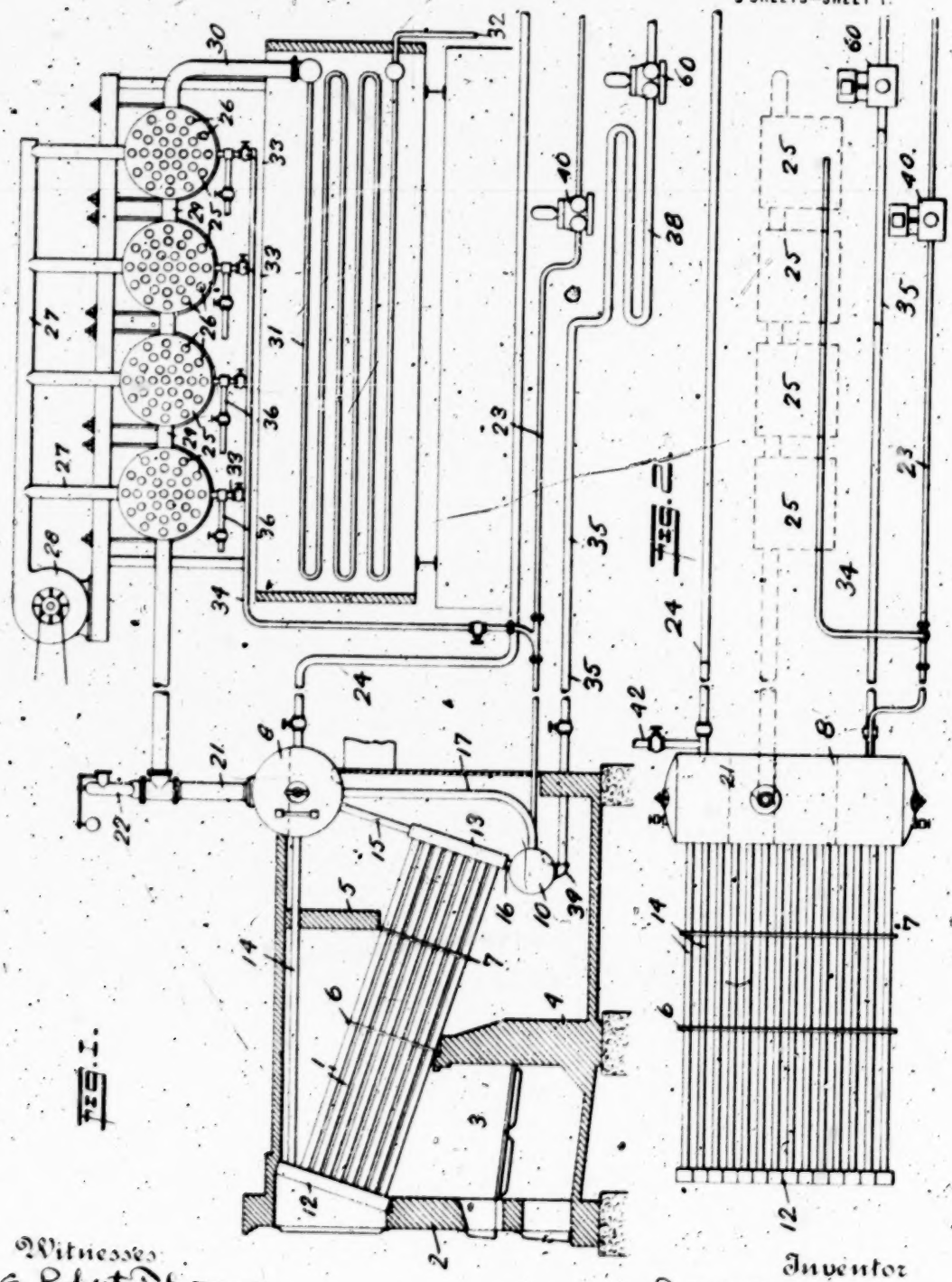

Fig. 1.

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OIL DISTILLING APPARATUS.

APPLICATION FILED MAY 8, 1915.

1,170,884. Patented Feb. 8, 1916.

3 SHEETS SHEET 2

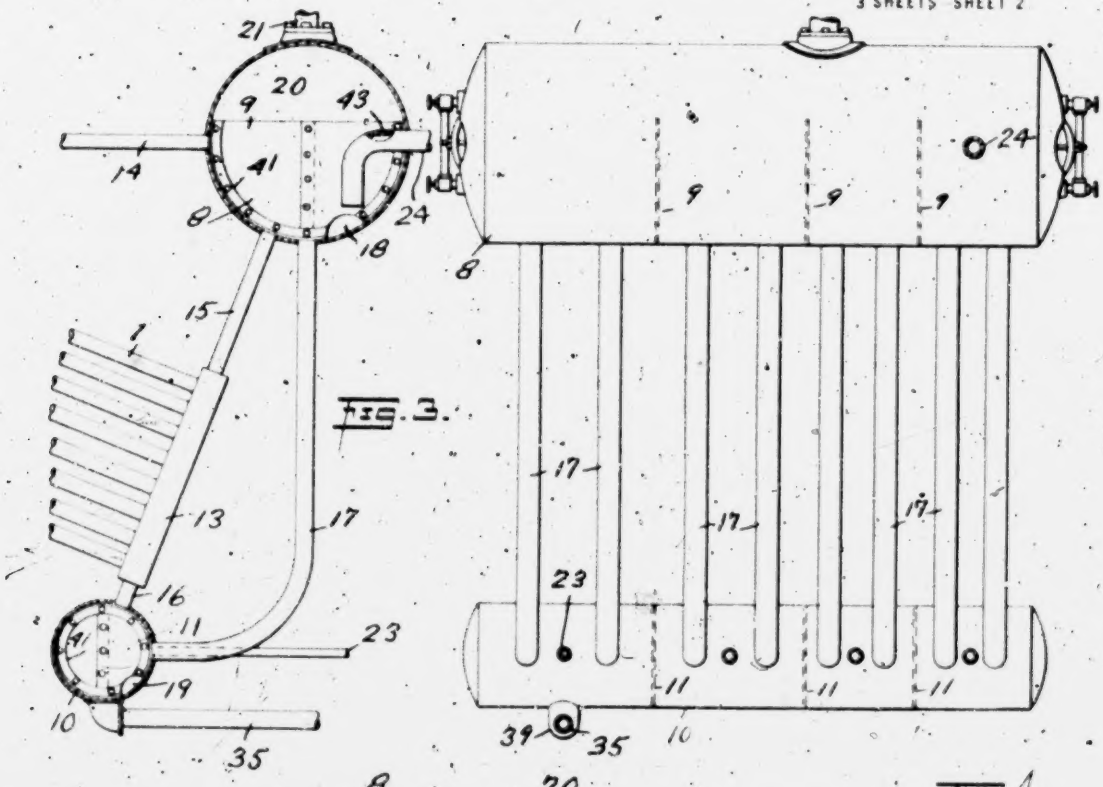

Fig. 3.

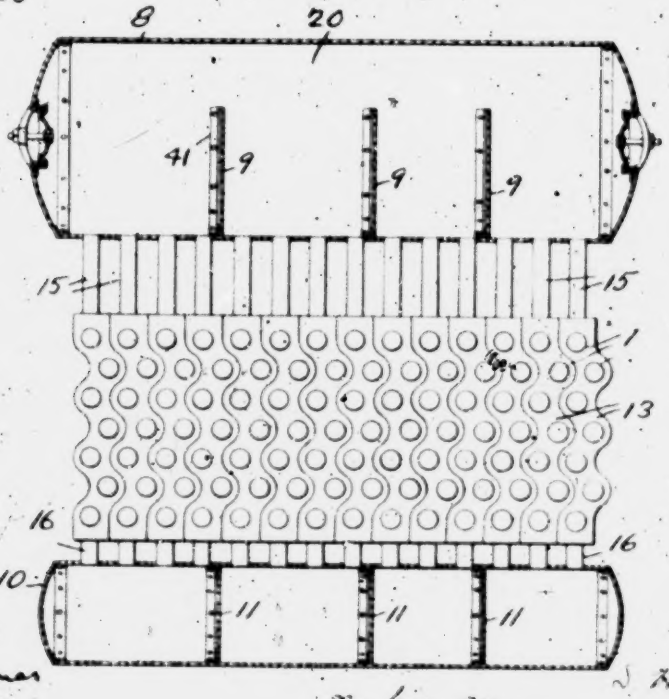

Fig. 4.

Fig. 5.

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OIL DISTILLING APPARATUS.

APPLICATION FILED MAY 8, 1915.

1,170,884. Patented Feb. 8, 1916.

3 SHEETS—SHEET 3.

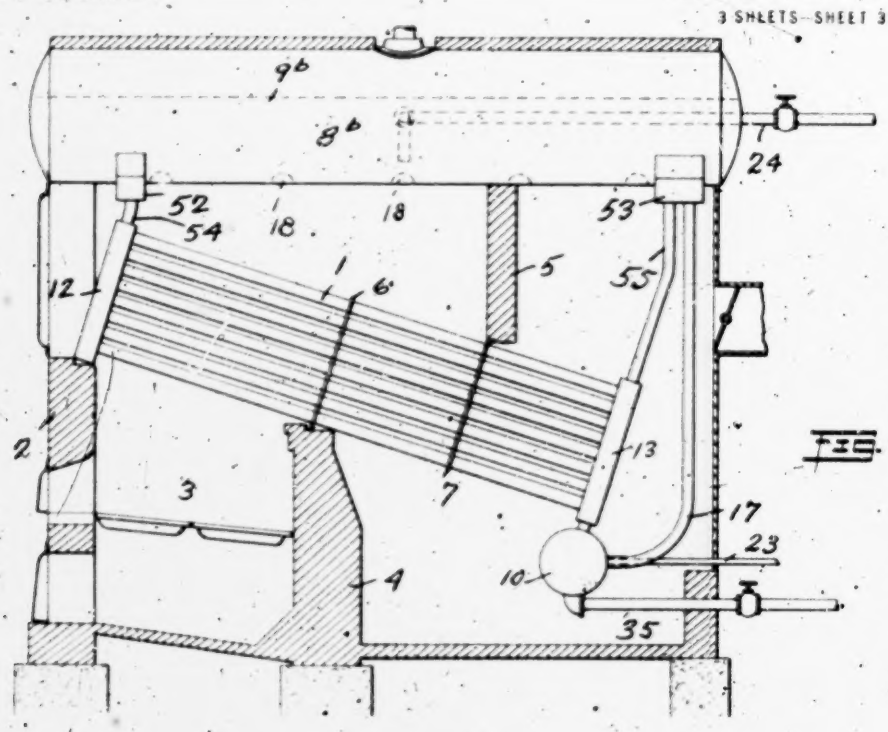


Fig. 6.

Fig. 7.

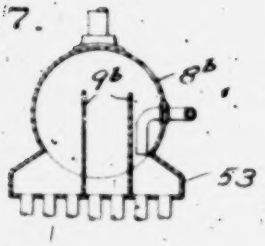


Fig. 8.

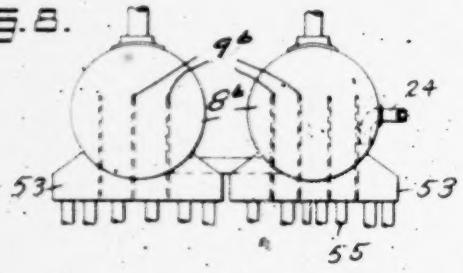
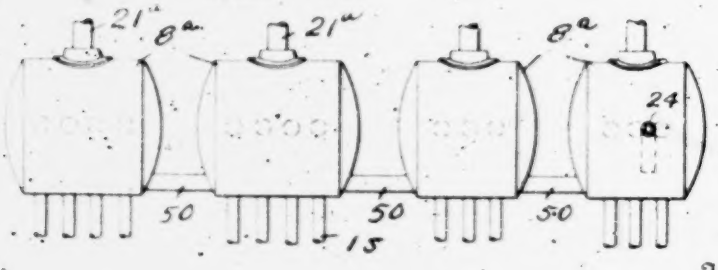


Fig. 9.



Witnesses
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S. H. Edwards
By [illegible] Attorney

UNITED STATES PATENT OFFICE.

SAMUEL H. EDWARDS, OF BAYONNE, NEW JERSEY, ASSIGNOR OF ONE-FOURTH TO TIDE WATER OIL COMPANY, OF BAYONNE, NEW JERSEY, A CORPORATION OF NEW JERSEY.

OIL-DISTILLING APPARATUS.

1,170,884. Specification of Letters Patent. Patented Feb. 8, 1916.

Application filed May 8, 1915. Serial No. 26,699.

To all whom it may concern:

Be it known that I, SAMUEL H. EDWARDS, a citizen of the United States, and a resident of Bayonne, in the county of Hudson and State of New Jersey, have invented certain new and useful Improvements in Oil-Distilling Apparatus, of which the following is a specification.

The object of the invention is to provide an advantageous apparatus for the continuous distillation of hydrocarbons.

The apparatus is especially suitable for continuous destructive pressure distillation of relatively high boiling point fractions resulting from petroleum distillation, for the purpose of converting the same wholly or partially into low boiling point products. The invention is not limited in its usefulness, however, to any one process or operation, and may be employed with advantage in place of apparatus used for the distillation of crude petroleum or the re-distillation of its distillates in accordance with various procedures.

In the manufacture of gasolene from high boiling point hydrocarbons by pressure distillation, and to a great extent in the art of petroleum distillation, it has been the practice to follow the "batch" or intermittent method of distillation, that being made necessary by the type of apparatus employed. This has involved a time loss of perhaps one-third, making only about two-thirds of the actual time employed effective, and compelling the refiner to construct a larger number of units than would have been necessary were it possible to employ the continuous distillation method. Another disadvantage of present day practice is the necessity of building comparatively large reservoirs or stills in order to start with a sufficient quantity of raw material to make the process economical and practical.

For the purpose of enabling this work to be carried on continuously I have designed a tubular still, composed of drums and heating tubes, sectionalized or partitioned, and so constituted with its connections and supply and discharge lines as to secure an automatic progressive circulation. Among the advantages of the still are cheaper construction and less plant investment than necessary heretofore to process a definite quantity of raw material, a material reduction in operating cost, due to the greater capacity and higher efficiency of the still, obtained by operating continuously, greater safety in operation and practicability of operating at much higher pressure than has been practicable heretofore. The apparatus is particularly suitable for economically and efficiently carrying on pressure distillation to a fractional degree only.

It is well known to those skilled in the art that, within certain limits, the lower boiling point fractions of the oils usually treated by pressure distillation are more easily "cracked", thermolyzed or converted into low boiling point hydrocarbons at the pressures and temperatures usually employed than the higher boiling point fractions of the oil to be treated. My apparatus makes it possible to carry on the process economically and efficiently to a fractional extent only by extending the operation to the degree of having cracked or thermolyzed principally those lower boiling point constituents of the oil being treated which are most easily converted, and leaving as a residue a product suitable for sale and use as a gas oil or fuel oil without further processing. The invention is useful as well, however, for carrying out the distillation of these fractions, or of crude petroleum or other petroleum products, until the residue has been reduced to the degree desired. In this connection, the still may be made of varying sizes by increasing or decreasing the number of sections, or two or more of the stills may be connected in series, according to the extent to which distillation is to be carried.

Other apparatus may be employed in conjunction with the still, more especially a series of aerial condensers for condensing out of the vapors the fractions of higher boiling points and returning the same to the still or making other disposition thereof as desired, the several aerial condenser units having individual outlets which may be connected by a common return line with the lower portion of the tubular still at one point, or by separate lines with different sections of the still, or which may be connected with receiving tanks if these fractions are not to be turned back into the still.

Various other features of the invention will become apparent as the specification proceeds.

In the accompanying drawings illustrat-

ing the invention: Figure 1 is a sectional side elevation of the apparatus, the pipe lines being shown broken away for economy of space and the stack connected with the furnace of the still being omitted for like reason; Fig. 2 is a plan view of the still and its pipe lines, with the brickwork setting omitted; Fig. 3 is an enlarged vertical longitudinal section through the rear portion of the still; Fig. 4 is a rear elevation of the still; Fig. 5 is a section taken on a plane intersecting the axis of the upper and lower drums of the foregoing figures; Fig. 6 is a sectional side elevation of a modified form of still; Fig. 7 is a cross-section through the longitudinal drum of Fig. 6; Fig. 8 is an end elevation indicating cross-connected longitudinal drums; and Fig. 9 is a rear elevation indicating semi-diagrammatically a transverse arrangement of cross-connected drum compartments.

These views show the preferred form of the apparatus and certain modifications thereof, but it is to be understood that the construction is susceptible of further modification and that changes may be made, and that parts may be added or taken away, as long as the essential character of the apparatus is not altered.

The construction shown in the drawings will now be briefly described. Reference will first be had to Figs. 1 to 5. The still comprises primarily a nest of heating tubes 1, which are shown disposed in a forwardly and upwardly inclined position within a setting 2, the fire-box 3 being beneath the forward, upper ends of the tubes. The course of the gaseous products of combustion from the fire-box is determined by the bridge wall 4, the depending wall 5, and baffles 6, 7 in the nest of tubes, so that the tubes are effectively exposed to the heat. The still also comprises an upper drum 8, which in accordance with the invention is partitioned by transverse diaphragms 9 so as to present a plurality of compartments which are connected in circuit with groups of tubes. A lower drum 10 is also provided and partitioned by diaphragms 11 like the upper drum, the compartments of the lower drum being connected with the lower or rear ends of the groups of tubes. The still thus consists of a plurality of sections, which may be greater or less in number, each section comprising a group of tubes and therewith connected drum compartments. The still is thus divided into a number of small circulating units, bringing the oil into rapid and repeated contact with the heating surface of the tubes, and allowing the vapor formed in each circulating unit to become disengaged from the liquid in the upper drum. The sections are connected in such manner that while the oil being treated is circulating continuously through the tubes of the various sections and giving up its vaporized portions in the upper drum, a progressive circulation of the oil as residue, less the vaporized portion, takes place from one section to another, successively. As illustrated, the partitions of the upper and lower drums are similarly placed, and corresponding upper and lower compartments are connected with the ends of the same sets of tubes, the communication between sections being through the diaphragms in the drums.

In Figs. 1 to 5, the upper drum is disposed transversely, partly inside and partly outside the rear and upper portion of the setting, above the rear, lower ends of the tubes. The lower drum is placed transversely within the lower rear portion of the setting, and is connected with the rear or lower ends of the tubes. The upper drum is connected with both ends of the tubes. The tubes are connected in tiers with sectional headers 12 and 13, the upper ends of which are connected by tubes 14 and 15 with the upper drum. The lower drum is connected with the lower ends of the headers by short tubes 16. In addition, in order to insure an adequate supply of oil to the heating tubes 1, the lower, or rear, ends thereof are connected with the upper drum by downcomers 17. The latter preferably open into the rear side of the lower drum, and may be two in number for each pair of upper and lower drum compartments, and of the same size as the tubes 15, though this may be varied. The connections between the drum compartments may be formed by openings 18 and 19 through the diaphragms near but somewhat above the bottoms, in order to guard against their becoming choked by deposits. These openings are preferably comparatively restricted in order that part of the oil in each section may be caused to circulate repeatedly therein before passing to the next section, or, in other words, to render the progress from section to section comparatively slow. Manifestly, however, the action may be varied by making the area of communication for the oil between compartments larger or smaller. The openings also perform the function of equalizing the level of the liquid in the several sections, to guard against any of the sections going dry.

The diaphragms of the lower drum preferably go all the way to the top thereof, being closed with the exception of the openings 19. The diaphragms of the upper drum, on the contrary, preferably terminate a substantial distance below the top of this drum, so as to leave a common vapor space 20 in the upper part. The same result would obviously be secured by appropriate openings in the upper parts of the diaphragms. From the top of this space there leads a vapor line 21, which may carry a safety valve 22.

The supply line 23, for raw oil or distillate to be re-distilled, preferably enters the lower drum, at the compartment at one end thereof. This compartment, the drum compartment above and the connected group of heating tubes constitute the first section. As shown in Fig. 5, the first section may be wider than the last section, including more of the heating tubes. The dimensions of the intermediate sections and the number of tubular units included thereby may vary. The residue discharge line 24 preferably leads from the upper drum compartment of the last section. Its inlet end may be inside the drum, a short distance above the bottom, and may extend upward and thence bend laterally, passing through the wall of the drum at such height that the liquid level determined by the height of overflow is below the tops of the diaphragms, to the end that communication for the oil between compartments shall be confined to the openings 18. A pump 40 in the supply line serves to deliver the fluid to the still at an appropriate rate.

The vapor line conducts the vapors to the first of a series of aerial condensers 25, which comprise a row of horizontal drums having air tubes 26 passing through them. Air is supplied to these tubes by an air line 27 having a blower 28, the cooling effect being thus definitely controllable. The vapor line enters the side of the first condenser drum, the interior of which around the cooling tubes is filled with the vapors when the still is in operation. The highest boiling point fractions condense here and settle in the bottom of the drum, which thus constitutes its own collector. From the opposite side of the first drum the vapors still uncondensed pass to the second drum by a short tube 29, and so on through the drums in series, fractions of successively lower boiling point being condensed out in the several drums and collecting in the bottoms thereof. The number and size of the aerial condensers may be varied in accordance with conditions and the particular end in view. From the last drum the remaining vapors pass by a line 30 to a water condenser 31, from which the crude gasolene or other distillate may be drawn off from time to time through a line 32. If the operation being conducted is the thermolyzing of high boiling point fractions having boiling points of upward of 400° F. (gas oil, etc.,) for the purpose of producing gasolene, the aerial condensers should be so proportioned as to knock back all of the oil fractions coming over with the vapors having higher boiling points than the desired naphtha-containing distillate, which, alone, is condensed in the water condenser.

Each of the aerial condensers has an individual outlet 33 from its bottom, and all these outlets may enter a common return line 34, which joins the supply line 23 and thus reaches the lower drum of the still, preferably entering the first compartment thereof, though this may be varied. In addition each of the aerial condenser outlets has a valved branch 36, and each of the compartments of the lower drum other than the first has a connection 23ª, which may be closed if not in use, so that by suitable piping, the arrangement of which will be obvious, the condensate of any or all of the aerial condensers may be returned to any one or more of the sections of the still, enabling any desired combination to be effected. Or the products condensed in the aerial drums may be drawn off to storage, for other disposition.

A line 35, leading from the bottom of the lower drum, part of which constitutes an extension of the return line, is connected through a cooler 38 with a pump 60, so that in event of emergency the still may be quickly emptied of oil. The drum fitting 39 of the line 35 is preferably located at the bottom of the drum and may be removed to facilitate cleaning out of carbon deposits from this drum. For the same purpose the diaphragms in the drums are made collapsible, so that they may be readily displaced after access is obtained through usual manholes. The particular construction may, of course, be varied, but as shown in Fig. 3, the desired end may be simply attained of making each diaphragm in two parts, bolted to each other at the middle and at the margins to angle irons 41 on the interior of the drums.

The overflow line 24, through which the residue escapes from the still may lead to storage, or as indicated by the branch 42 may lead into or constitute the supply line of a second still, which may be in all respects like the first and is therefore not illustrated. While it is possible to build one still with sufficient circulating units to carry on the process to any desired degree of concentration of the residue, it is not advisable for practical reasons to carry the still beyond a certain size, preferably not more than twenty tubes wide, because of mechanical limitations which may be encountered. If it is desired to carry the process beyond the degree of concentration attainable in one such still the liquid residue in the last compartment of the upper transverse drum of the first still may be led to the first section of the lower drum of a second still, and the process carried on from that point in a way entirely similar to that in the first still except that, due to the heavier concentration and the higher average boiling points of the material composing such residue, higher temperatures will naturally prevail. The process may be carried in a third and even a fourth still, to a point where the degree of concen-

tration is too great to admit of further practical continuous processing of the residue. At this point the residue will flow out continuously at a rate conforming to the speed of the process and can be collected in a suitable container. A vent opening 43 is formed in the top of the overflow line, at a point within the drum. The function of this vent is to prevent the possibility of a siphoning action being set up, thereby creating a tendency to lower the level of the oil below the predetermined point fixed by the position of the overflow or discharge line 24. The illustrative modifications of the preferred construction will now be referred to briefly. Fig. 9 shows an embodiment which may be in all essentials like that described, except that the upper drum compartments 8^a, instead of being formed by partitions in a common drum, constitute separate sections which are cross-connected as indicated at 50. Each of these compartments may have its own vapor outlet 21^a.

In Figs. 6 and 7, a longitudinal drum 8^b is shown, which is divided into partitions by longitudinal diaphragms 9^b, having the same functions as the diaphragms 9. This drum connects with the headers of the heating tubes by boxes 52 and 53, into which the diaphragms extend, and tubes 54 and 55. Otherwise than the longitudinal position of the drum, the still and its mode of operation may be precisely like those of the preferred form, and the construction is so illustrated. Another modification, indicated in Fig. 8, may be exactly like Fig. 6, except that it comprises a number of cross-connected longitudinal drums, located, it will be understood, in the same setting.

What I claim as new is:

1. A continuous tubular oil still comprising a plurality of connected sections comprising groups of heating tubes and therewith connected drum compartments, and means for supplying and discharging oil to and from different sections whereby the oil being heated in circulation progresses from one section to another successively.

2. A continuous tubular oil still comprising a furnace and setting, in combination with a plurality of transversely connected still sections comprising drum compartments and heating tubes connected therewith and exposed to the heat of the furnace, and means for supplying and discharging oil to and from different sections whereby the oil being heated in circulation progresses from one section to another transversely of the still.

3. A continuous tubular oil still comprising a nest of inclined heating tubes, a fire-box under the upper portion thereof, a plurality of drum compartments above and connected with the tubes, the compartments and therewith connected tubes constituting sections through which the oil circulates successively, a supply line connected with the first section, and an overflow line connected with the last section.

4. A continuous tubular oil still comprising a fire-box, a nest of tubes arranged in the path of the gases flowing from the fire-box, a plurality of upper drum compartments connected in circuit with the tubes, a plurality of lower drum compartments, the drum compartments and therewith connected tubes constituting sections through which the oil circulates successively, and oil inlet and outlet lines connected with different sections.

5. A continuous tubular oil still comprising a furnace, a nest of tubes therein, a plurality of drum compartments, each compartment being connected with the opposite ends of a set of the tubes, whereby the oil may circulate repeatedly in each section comprising a drum compartment and its connected tubes, connections between the compartments whereby the oil may pass from one section to another, and an inlet and an outlet for oil connected with different sections.

6. A continuous tubular oil still comprising a furnace, a nest of tubes arranged in the path of the products of combustion, a drum above and connected with the tubes, diaphragms in the drum dividing the same into compartments, and means whereby the oil being heated in circulation progresses from one compartment to another.

7. A continuous tubular oil still comprising a plurality of connected sections comprising a drum divided into compartments and heating tubes connected with the compartments, and means for supplying and discharging oil to and from different sections.

8. A continuous tubular oil still comprising a nest of tubes, a drum above and connected in a circulatory system with the tubes, diaphragms in the drum dividing the same into oil compartments with a common vapor space in the upper portion of the drum, means for leading off and condensing the vapors from said space, and oil inlet and outlet lines connected so that the circulating oil passes from one drum compartment to another.

9. A continuous tubular oil still comprising a nest of heating tubes, upper and lower drums connected therewith, said drums being divided into compartments, a supply line, and an outlet for the residue.

10. A continuous tubular oil still comprising a nest of tubes, upper and lower drums divided into corresponding compartments, each upper compartment and its corresponding lower compartment being connected with a set of the tubes, connections between the compartments whereby the oil in circu-

lation may pass from one compartment to another, and supply and residue discharge lines connected with different compartments.

11. A continuous tubular oil still comprising a nest of tubes, upper and lower drums connected with the tubes and divided by diaphragms into compartments, the diaphragms in the upper drum having open communication from compartment to compartment in the upper portion of the drum, a vapor line connected with said upper portion, oil condensing means connected with said line, and supply and residue discharge lines connected with different compartments.

12. A continuous tubular oil still comprising a nest of heating tubes, a drum connected therewith, partitions dividing said drum into compartments with openings through the diaphragms toward the bottom of the drum, and supply and residue discharge lines, substantially as described.

13. A continuous tubular oil still comprising a nest of heating tubes, a drum above and connected in circuit with said tubes, and diaphragms in the drum dividing the same into compartments, said diaphragms having open communication between the compartments in the upper part of the drum above the liquid level and having in addition openings below the liquid level.

14. A continuous tubular oil still comprising a nest of heating tubes, an upper drum connected with opposite ends of said tubes, a lower drum connected with the tubes at one end only, diaphragms dividing said drums into compartments, and an oil supply line and a residue discharge line connected with different parts of the still so as to cause the oil in circulation to progress from compartment to compartment.

15. A continuous tubular oil still comprising a nest of heating tubes, an upper drum connected with opposite ends of said tubes, a lower drum connected with the tubes at one end only, diaphragms dividing said drums into compartments, and connections between adjoining compartments, in combination with an oil supply line, a residue discharge line connected with a remote portion of the still from the supply line, a vapor line leading from the upper drum, and oil condensing means connected with said vapor line.

16. A continuous tubular oil still comprising a nest of heating tubes, and a transverse drum thereabove, said drum being divided transversely into compartments, said compartments communicating with each other and each compartment connected with opposite ends of a set of the tubes, in combination with supply and residue discharge lines connected so as to cause the oil in circulation to progress from one compartment to another.

17. A continuous tubular oil still comprising a fire-box, a setting, a nest of tubes therein in the path of the products of combustion, a plurality of upper drum compartments connected with opposite ends of said tubes, a plurality of lower drum compartments connected with the tubes at one end thereof, an oil supply line connected with one of the lower compartments, and a residue discharge line connected with a remote upper compartment.

18. A continuous tubular oil still comprising a nest of tubes, upper and lower drums connected therewith, diaphragms dividing the drums into compartments, an oil supply line connected with the first of the lower compartments, an overflow line connected with the last of the upper compartments, and a vapor line connected with the upper drum and leading to an oil condenser.

19. A continuous tubular oil still comprising a nest of tubes, upper and lower drums connected therewith, diaphragms dividing the drums into compartments, an oil supply line connected with the first of the lower compartments, an overflow line conected with the last of the upper compartments, a vapor line connected with the upper drum and leading to an oil condenser, and a return line for conducting condensate back to the lower drum.

20. A continuous tubular oil still comprising a nest of tubes, a plurality of upper drum compartments connected in circuit with groups of said tubes in such manner that the oil in circuit may progress from one compartment to another, oil supply and residue discharge lines so connected as to cause such progression, a vapor line, fractional condensing means connected therewith, and a return line for conducting condensate from said condensing means back to the lower portion of the still.

21. A continuous tubular oil still comprising a plurality of communicating sections, each comprising a portion of a nest of tubes and an upper drum compartment connected therewith, and oil supply and residue discharge lines connected with different sections, in combination with a vapor line, fractional condensing means connected with said vapor line, and means whereby condensate may be returned to one or other of said sections as desired.

22. A continuous tubular oil still comprising a plurality of communicating sections, each comprising a portion of a nest of tubes and an upper drum compartment connected therewith, and oil supply and residue discharge lines connected with different sections, in combination with a vapor line, fractional condensing means connected with

said vapor line, condensate outlets from different portions of said condensing means, and means for returning the condensates to a section or sections of the still or making other disposition thereof as desired.

23. A continuous tubular oil still comprising a nest of tubes, a drum above the tubes divided into compartments connected in circuit with the tubes in such manner that the oil in circulation may progress from one compartment to another, means for supplying the oil to be distilled to one portion of the compound circulatory system constituted by the tubes and compartments, a residue discharge line leading from a drum compartment remote from the supply inlet, oil condensing means connected with the vapor line, and a return line from said condensing means to a lower portion of the still.

24. A continuous tubular oil still comprising an inclined nest of tubes connected in tiers between sectional headers, a fire-box below the upper portion of the nest, an upper drum divided into compartments connected with the upper ends of both the front and back headers, a lower drum connected with the lower ends of the back headers, additional circulators extending downward from the upper drum compartments and opening into the lower drum compartments, and means including oil supply and residue discharge lines whereby the oil in circulation is caused to progress from section to section of the still.

25. A continuous tubular oil still comprising a nest of tubes connected in tiers to sectional headers at their ends, a plurality of drum compartments above the tubes, connections between said drum compartments and the upper ends of said sectional headers, additional circulators extending downward from the drum compartments and connecting with the lower portion of the nest of tubes at one end, and means including oil supply and residue discharge lines whereby the oil in circulation is caused to progress from section to section of the still.

26. A continuous tubular oil still comprising a nest of tubes, upper and lower drums divided into compartments connected with the tubes, means including oil supply and residue discharge lines whereby the oil in circulation is caused to progress from section to section of the still, a vapor line leading from the upper drum, an oil condensing means connected with the vapor line, a condensate return line for condensate leading from said condensing means and opening into the bottom of the lower drum, and pumping out means connected with said return line.

27. A continuous tubular oil still comprising a nest of tubes, a drum connected therewith, collapsible diaphragms dividing said drum into compartments, and means including oil supply and residue discharge lines whereby the oil in circulation is caused to progress from one section of the still to another.

In testimony whereof I have signed my name hereto.

SAMUEL H. EDWARDS.

Witnesses:

CLAUDE K. EDWARDS,

JAMES J. MCGRATH.

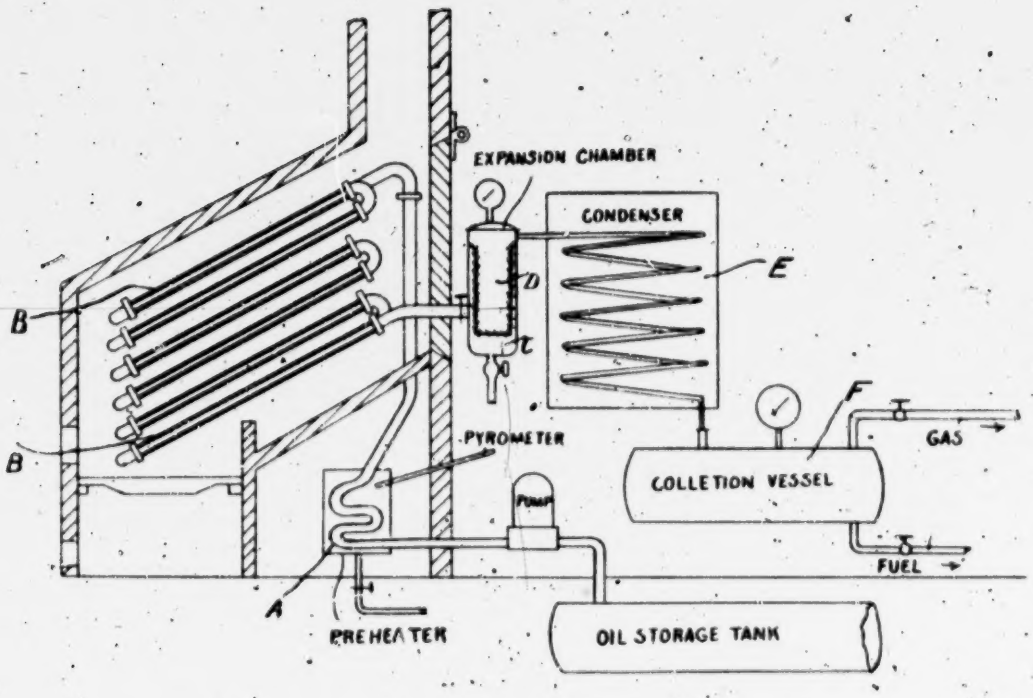
3194

W. A. HALL.

PROCESS FOR THE CONVERSION OF HEAVY HYDROCARBONS INTO LIGHTER HYDROCARBONS.

APPLICATION FILED JULY 24, 1914.

1,175,909. Patented Mar. 14, 1916.



Witnesses
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UNITED STATES PATENT OFFICE.

WILLIAM A. HALL, OF NEW YORK, N. Y.

PROCESS FOR THE CONVERSION OF HEAVY HYDROCARBONS INTO LIGHTER HYDROCARBONS.

1,175,909. Specification of Letters Patent. Patented Mar. 14, 1916.

Application filed July 24, 1914. Serial No. 853,965.

To all whom it may concern:

Be it known that I, WILLIAM AUGUSTUS HALL, a citizen of the United States Republic, and resident of New York, N. Y., United States of America, have invented a certain new and useful Improvement in Processes for the Conversion of Heavy Hydrocarbons Into Lighter Hydrocarbons, of which the following is a specification.

This invention relates to improvements in the hydrogenation of heavy hydrocarbons with the object of converting them into hydrocarbons of lower specific gravity and boiling point such as can be used successfully in internal combustion engines of the automobile type.

In the practice of other processes of hydrogenation known to me the hydrogenation of the oil has been effected by affixing to the hydrocarbon molecule additional hydrogen derived from some extraneous source, which may be free gaseous hydrogen, or producer gas, or nascent hydrogen from the decomposition of water, the affixation being usually accomplished by the well known catalytic action of nickel or other metal which will act in a similar manner, a process of this general character being claimed in my copending application 769,610, filed May 24, 1913. These processes have been found very expensive as free hydrogen is a costly material, and the N, CO and CO_2 content of producer or water gas has presented difficulties.

The improved process consists in subjecting the volatilized heavy hydrocarbon, in the absence of steam or any extraneous source of hydrogen, either in the form of water, steam or added hydrogen, to the action of heat and pressure in the presence of a catalyst capable of effecting the fixation of hydrogen to hydrocarbons, allowing the products to expand and thereby deposit carbon, and cooling the residual products to produce by condensation a liquid hydrocarbon containing less carbon than the said heavy hydrocarbon, and especially adapted for use in high speed internal combustion engines.

It has also been proposed to pass a mixture of oil and water or steam through tubes containing metallic nickel rods in a retort maintained at a dull red heat. My invention is distinguished from such a process in that I pass the vaporized oil through tubes containing rods of nickel or other hydrogenating catalyst, but with the addition thereto of no hydrogen, and no water or steam.

If the hydrocarbon oil is heated under a moderate pressure, say a pressure of about 5 atmospheres, to a temperature of upward of 600° C., in the presence of the catalyst, and in the absence of steam or any extraneous source of hydrogen, either in the form of water, steam or added hydrogen gas, an efficient conversion of the oil takes place, the oil being partially decomposed and gases set free, such gases being in turn decomposed by the heated catalyst with liberation of hydrogen which in a nascent state is to a considerable extent affixed to the condensable portion of the decomposed hydrocarbon oil.

The catalysts I employ are substances such as the metals, or oxids of the metals, nickel, cobalt, silver, palladium, chromium or manganese, which substances are hereinafter referred to under the term "catalytic body of the nickel type."

Apparatus suitable for the performance of the process is shown diagrammatically in the accompanying drawing.

As shown, the apparatus includes a preheater A for raising the temperature of the oil and to some extent volatilizing the same before it enters the tubular converter B, so that the gas may be produced at as early a stage in the process as possible.

The converter shown is constituted by a serpentine inclined metallic tube so arranged that the circulation is through the top section, then down and through the next, and so on to the bottom, the exposure being at first to the lowest temperature, which is at the top, and gradually increasing toward the bottom. In the tubular elements of the converter is placed the catalytic material which rests in contact with the heated walls of the tube. From the converter B the products are passed into an expansion chamber C where their temperature is somewhat reduced. The said expansion chamber C may be provided with a metallic gauze screen D, preferably of conical shape, which will collect and extract any loose carbon that may be set free (it being found that such carbon is most readily deposited at the

point where expansion occurs and to the greatest extent if the pressure be suddenly reduced from that in the converter (about 5 atmospheres) down to atmospheric pressure). This loose carbon is of course a product of the decomposition and its extraction from the heavy oil to a large extent accounts for the reduction of the specific gravity.

It is to be noted that the pressure of the vapors drops materially, in passing from the converter B to the chamber C. This drop in pressure appears to aid materially in the deposition of free carbon in large quantities in the receptacle C. By causing the carbon to deposit in the receptacle C, instead of in the elements of the converter B, there is no danger of the converter being clogged up by means of this loose carbon.

It will be noted that the gases and vapors produced by the decomposition of the oil, will be caused to flow rather rapidly through the retort, and since the cross section of the space in the retort is rather small, owing to the fact that the metal rod therein takes up quite a large part of the space therein, the current of gases and vapors flowing through the retort will carry along all the free carbon, or soot-like material, consequently not much of this will deposit within the retort. After the pressure falls, and the gases enter the larger chamber C, most all the free carbon will deposit in the expansion chamber C, and on the gauze member D. Tarry matters will likewise be separated in the chamber C. From the said expansion chamber C the products are passed through a cooling condenser E and into a receiving tank F from which can be extracted any fixed gases that have not combined with the condensable portions. The condensate is found to be an entirely different product from the oil started with—it has a much lower specific gravity and boiling point and when redistilled and fractionated yields a large portion of volatile spirit eminently adapted for use in automobiles. For instance if the raw material used be "gas oil" (that being a refinery distillate having a boiling point above the boiling points of petrol and lamp oil) it will yield from 50 to 70% of a fuel of a specific gravity of about .765 with a boiling point which is lower than that of commercial petrol. The product of this process also contains a proportion of unsaturated hydrocarbons. The quantity of unsaturated hydrocarbons may vary more or less, but the quantity is always rather small, as compared with the products of some of the other processes with which I am familiar. Of course it is not necessary to redistil the condensate, as the fractionation can be effected by a dephlegmator situated between the converter and the condenser.

Having described my invention, I declare that what I claim and desire to secure by Letters Patent of the United States is:—

1. The herein described method of converting relatively heavy liquid hydrocarbons into lighter and more volatile hydrocarbons, which comprises the step of vaporizing said relatively heavy hydrocarbons, and causing a current of the vapors to flow, in the absence of extraneous hydrogen, and in the absence of free oxygen, in contact with a catalyst capable of effecting the fixation of hydrogen to hydrocarbons, said catalyst being maintained at a temperature not materially below 600° C., and said vapors being being maintained under pressure materially above atmospheric, thereafter allowing the products to expand into a separate expansion vessel, wherein the pressure is materially lower, and the speed of the gases is materially lower, than in the vessel containing the catalyst, whereby the bulk of the free carbon separates, and is deposited in said expansion vessel, and thereafter cooling the residual products, to produce by condensation, a liquid hydrocarbon containing less carbon than said relatively heavy hydrocarbon and especially adapted for use in high speed internal combustion engines.

2. The herein described method of converting relatively heavy hydrocarbons into lighter and more volatile hydrocarbons, suitable for use in internal combustion engines, which process comprises vaporizing said relatively heavy hydrocarbons alone, causing the vapors thereby produced, in the absence of extraneous hydrogen, and in the absence of free oxygen, to flow rapidly through a confined space under a pressure of several atmospheres, at a temperature sufficiently high to crack at least a portion of said hydrocarbon, in contact with a catalytic body, allowing the vapors so produced to expand into a separate expansion vessel, wherein the pressure is materially lower, than in the receptacle containing the catalytic body, and wherein the rate of flow of the vapors is lower than in the receptacle containing the catalytic body, whereby free carbon will be deposited in said expansion vessel, and thereafter cooling the vapors to condense liquid hydrocarbons.

3. The herein described method of converting relatively heavy liquid hydrocarbons into lighter and more volatile hydrocarbons adapted for use in high speed internal combustion engines, consisting in vaporizing the relatively heavy hydrocarbons, and subjecting the vapors, under pressure, in the absence of extraneous hydrogen, and in the absence of free oxygen, to the action of a catalyst capable of effecting the fixation of hydrogen to hydrocarbons at a temperature sufficiently high to cause the separation of free carbon, allowing the products to expand into a separate expansion vessel, wherein a

pressure is maintained, considerably lower than the pressure in the receptacle containing the catalyst, whereby the non-volatile materials are separated in said expansion vessel, and thereafter cooling the residual products, to produce by condensation, a liquid containing less carbon than the relatively heavy hydrocarbons employed.

4. In the treatment of hydrocarbons, of relatively high boiling points, for the production of hydrocarbons of lower boiling points, the step of passing a current of vaporized hydrocarbons, at a cracking temperature, and in the absence of extraneous hydrogen, in contact with a hydrogenating catalyst, under a pressure of several atmospheres.

5. The step of passing a current of hydrocarbon vapors under a pressure materially above atmospheric, in contact with a nickel catalyst, at a temperature sufficiently high to liberate free carbon, in the absence of extraneous hydrogen.

6. In the production of motor fuel from heavier hydrocarbons, the step of passing hydrocarbon vapors alone into contact with a catalytic, at a temperature above 600° C., under pressure materially above atmospheric.

7. The herein described method of converting relatively heavy liquid hydrocarbons into lighter and more volatile hydrocarbons, which comprises the step of vaporizing said relatively heavy hydrocarbons, and causing a current of the vapors to flow, in the absence of extraneous hydrogen, and in the absence of free oxygen, in contact with a catalyst capable of effecting the fixation of hydrogen to hydrocarbons, said catalyst being maintained at a temperature above about 600° C., and said vapors being maintained under pressure materially above atmospheric, thereafter allowing the products to expand into a separate expansion vessel, wherein the pressure is materially lower, and the speed of the gases is materially lower, than in the vessel containing the catalyst, passing the gases and vapors while at said lower pressure, through a device capable of removing free carbon, and thereafter cooling the residual products, to produce by condensation, a liquid hydrocarbon containing less carbon than said relatively heavy hydrocarbon and especially adapted for use in high speed internal combustion engines.

8. The herein described method of converting relatively heavy hydrocarbons into lighter and more volatile hydrocarbons, suitable for use in internal combustion engines, which process comprises vaporizing said relatively heavy hydrocarbons alone, causing the vapors thereby produced, without the addition of other gases or vapors, to flow rapidly through a confined space under superatmospheric pressure, and at a temperature sufficiently high to cause the liberation of free carbon, while in contact with a catalytic body, allowing the vapors so produced to expand into a separate expansion vessel, wherein the pressure is materially lower than in the receptacle containing the catalytic body, and wherein the rate of flow of the vapors is lower than in the receptacle containing the catalytic body, and passing the gases and vapors through a separating medium.

9. In the production of motor fuel, the step of suddenly lowering the pressure of a flowing mixture containing gases and vapors and containing suspended particles of free carbon carried by said mixture, while causing said gases and vapors to enter an expansion vessel, wherein the speed of flow of the gases and vapors is materially decreased.

10. A process of converting heavy hydrocarbon oils into hydrocarbons of lower boiling points which comprises passing the vapors of the hydrocarbons to be treated, under pressure materially above atmospheric and in the absence of steam, over a substance capable of producing a catalytic action, while maintaining said substance at a temperature approximating a red heat.

11. A process of converting heavy petroleum oils into hydrocarbons of lower boiling points which comprises passing the vapors of the hydrocarbons to be treated, under superatmospheric pressure and in the absence of steam, over a hydrogenating catalyst while maintaining said catalyst at a temperature approximating a red heat.

12. A process of converting heavy hydrocarbon oils into hydrocarbon oils having lower boiling points, which comprises passing the vapors of said heavy hydrocarbon oils, under a pressure materially above atmospheric, and in the absence of steam, over a catalyst, while maintaining said catalyst at a temperature approximating a red heat.

13. In the manufacture of motor fuel from hydrocarbon oils of which at least portions have boiling points materially higher than those of ordinary gasolene, the herein described improvement which comprises passing such oil, in the form of a flowing current, in the substantial absence of extraneous water, through a coil maintained at a temperature not materially below 500° C., while at a pressure sufficiently low to allow vaporization, but materially above atmospheric, and thereafter rapidly lowering the pressure of the flowing mixture containing gases and vapors and containing suspended particles of free carbon carried by said mixture, and causing said gases and vapors to enter an expansion vessel, wherein the speed of flow of the gases and vapors is materially decreased.

14. A process of converting heavy hydrocarbon oils into hydrocarbons of lower boil-

ing points which comprises passing the vapors of the hydrocarbons to be treated, under a pressure of several atmospheres, in the absence of steam, over a metallic substance capable of producing a catalytic action, while maintaining said substance at a temperature capable of cracking the heavy oils.

15. A process of converting lamp oils or other hydrocarbons into hydrocarbons of lower boiling points, which comprises passing the vapors of the hydrocarbons to be treated, under a pressure of several atmospheres, over a catalytic metal maintained at a temperature at which said catalytic metal possesses catalytic activity.

16. A process of converting heavy hydrocarbons into hydrocarbons of lower boiling points which comprises passing the vapors of said hydrocarbons, under superatmospheric pressure and in the absence of steam or added hydrogen over a substance capable of producing a catalytic action, while maintained at a temperature capable of cracking oils.

17. A process of converting heavy hydrocarbons into hydrocarbons of lower boiling points, which comprises passing the vapors of said heavy hydrocarbons in the absence of steam or other extraneous hydrogen, under superatmospheric pressure, over a "catalytic body of the nickel type," at a temperature approximating a red heat, allowing the products of the reaction to expand to a lower pressure, and removing the solid materials from the vaporous products.

18. In the manufacture of motor fuel from hydrocarbon oils of which at least portions have boiling points materially higher than those of ordinary gasolene, the step of passing such an oil in the form of a flowing current, in the substantial absence of extraneous water, through a coil maintained at a temperature not materially below 500° C., while at a pressure sufficiently low to allow vaporization, but materially above atmospheric.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM A. HALL.

Witnesses:
ALFRED S. BURBEY,
O. J. WORTH.

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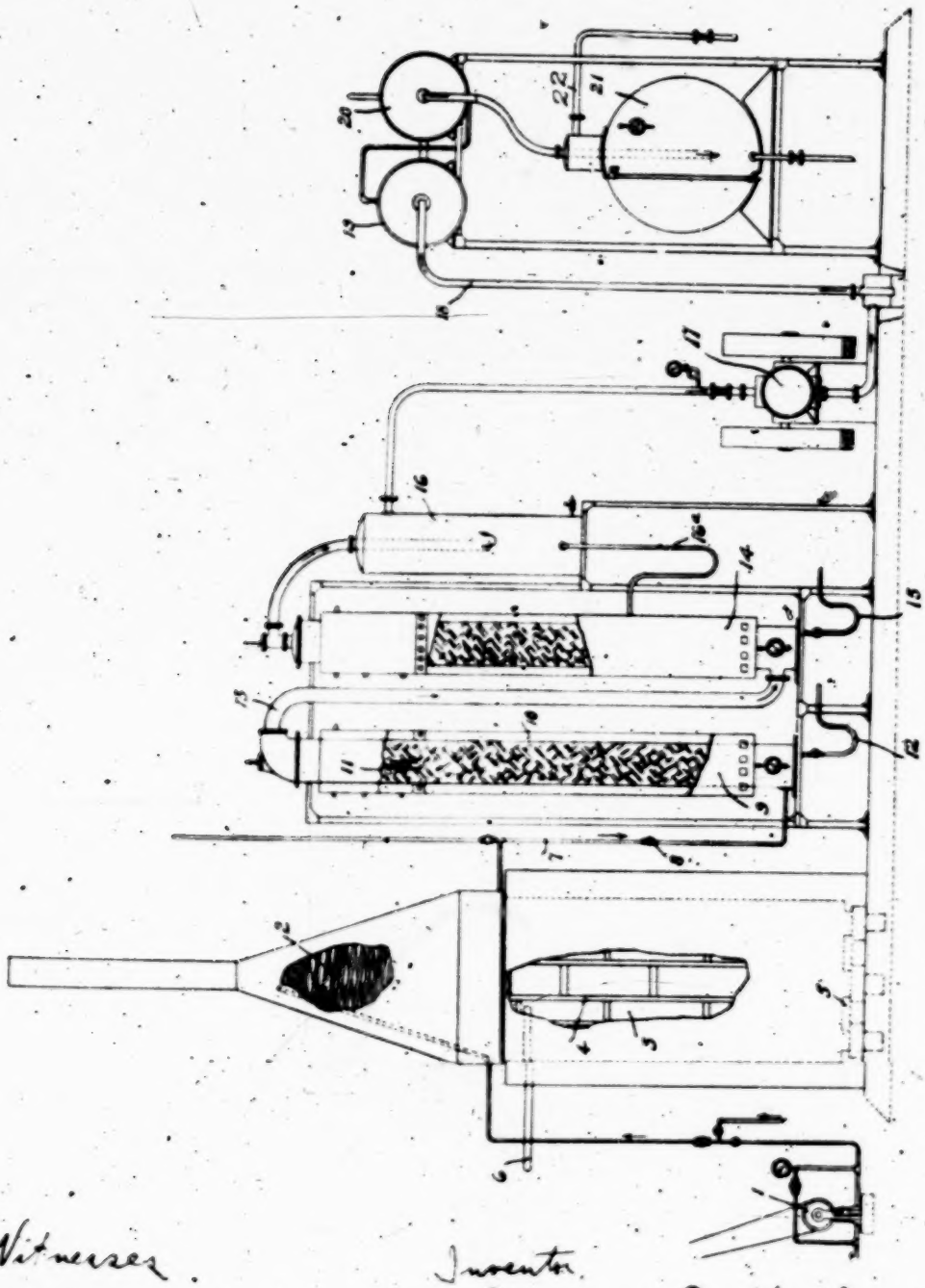
W. A. HALL.

PROCESS OF MAKING MOTOR FUEL.

APPLICATION FILED JAN. 23, 1915.

1,175,910.

Patented Mar. 11, 1916.



Witnesses.

A J Hayworth

B Heidenreich

Inventor.

William A. Hall - by

A. B. Foster

his Attorney

UNITED STATES PATENT OFFICE.

WILLIAM AUGUSTUS HALL, OF NEW YORK, N. Y.

PROCESS OF MAKING MOTOR-FUEL.

1,175,910. Specification of Letters Patent. Patented Mar. 14, 1916.

Application filed January 23, 1915. Serial No. 3,955.

To all whom it may concern:

Be it known that I, WILLIAM AUGUSTUS HALL, a citizen of the United States of America, and residing at New York city, New York, United States of America, have invented a certain new and useful Improvement in Processes of Making Motor-Fuel, of which the following is a specification.

This invention relates to the production of a new fuel suitable for use in automobile engines and possessing peculiar and highly valuable qualities not possessed by the ordinary gasolene of commerce. It is a slow burning fuel yet has an initial boiling point as low as gasolene and as large fractions volatile at low temperature say below 80° C. It is substantially free from liability to pre-ignite and therefore in an engine using the fuel, knocking does not occur even with the spark advanced to so great an extent as with ordinary gasolene. As a direct result there is much less wear and tear on the engine, and the engine can be operated while under full load at lower engine speed or on a higher gear than when run on gasolene, which means a considerable saving in fuel consumption, less frequent changing of gears and slipping of clutches. Such fuel has been found particularly advantageous for use in commercial vehicles and in city traffic where frequent stopping and starting is required. This new fuel produced in the manner hereinafter described can be "cut" at a higher temperature than can a gasolene—it can be "cut" say at 180° C. as compared with 160° C. in the case of an ordinary gasolene. Its larger fractions volatile at low temperature have been found to carry complete combustion to the fractions volatile only at the highest temperatures, a considerably increased mileage per gallon consumed being the result.

The low flash point and low initial boiling point give in an engine run on the fuel, great ease in starting in cold weather, and owing to its large fractions volatile at low temperatures great flexibility and quickness of acceleration is obtained. It has been found that as great flexibility and ease of starting can be obtained with this fuel when "cut" at 180° C. and of specific gravity 0.760 as can be obtained on gasolene of specific gravity 0.730 "cut" at 160° C.

A distinguishing characteristic of the new fuel is that it contains a proportion of unsaturated hydrocarbons which proportion will naturally vary with the oil used in its production. It contains a large percentage of hydrocarbons of the ethylene series but is nevertheless quite free from the objectionable features ordinarily inherent in products containing more than a small percentage of hydrocarbons of this series. The fuel having these peculiar and highly valuable properties is the direct result of an endothermic chemical reaction between a gas which would be permanent under ordinary conditions of temperature and pressure, and a vapor of a hydrocarbon spirit which vapor if condensed to a liquid in the customary manner at atmospheric temperature, would not answer the purpose of a satisfactory motor fuel, the combination of the permanent gas and vapor being effected by mechanical compression at a temperature sufficiently high to maintain the spirit portion under treatment, largely or wholly in the state of vapor. The process of production therefore has as its main feature the bringing about of this endothermic reaction the other stages being the production of the gas and vapor the bringing of them into the right condition for reaction and the treatment subsequent to the reaction to produce a refined spirit. The process thus consists of the following steps:

1. Cracking an oil—(which may be crude, "gas", fuel, lamp or almost any distillate that in itself has a range of boiling temperatures that would not permit its use as a fuel in the ordinary automobile engine)—in a continuous tube of small size, one to three inches, and of sufficient length, at an average temperature of from 540° C. to 600° C. on the exterior of the tube and under pressure preferably of about 75 lbs. per square inch, with a speed of flow of oil in the pipe regulated to produce a maximum of cracking with a minimum of fixed or permanent gas consistent with economy of operation.

2. Expanding the product subsequent to the cracking operation by reducing the pressure.

3. Cooling the vapors and gases when in this expanded state and from them separating fractions which have relatively high boiling points.

4. Producing an endothermic chemical reaction between the gases and vapors, by compressing the same, under substantially adiabatic conditions, in a mechanical compressor to a pressure preferably from 100 to 125 lbs. per square inch together with all the gas that has been produced along with all the spirit vapors that boil below the point of "cut", admitting these into the cylinder of the compressor at a temperature sufficiently high that they enter while in the shape of vapor and mist, the fixed gas that has not been attached being permitted to separate after cooling subsequent to the mechanical compression and be collected for other use subsequent to compression. I use the term "adiabatic", in this specification in the same sense in which said term is defined in Hasting and Beach's *General Physics*, (published, Boston 1899) in which it is stated that "a body is said to undergo an adiabatic change when its condition is altered, without its gaining or losing heat to other bodies". In the process of the present invention, I compress the gases and vapors, without materially adding to or taking away from the number of heat units present in the gases and vapors, by any influences outside the gases and vapors present. There may, of course, be a small amount of heat radiated or otherwise lost from the surface of the compressor, to the outside atmosphere, but I do not purposely take away or add to the heat units. It is to be noted, that the endothermic reaction which takes place in the gases themselves is not "gaining or losing heat to other bodies."

5. Clarifying and deodorizing the product by extracting the yellow resinous colloidal matter which it contains, preferably by distilling it in the presence of a small amount of fullers' earth.

The accompanying drawing illustrates an apparatus suitable for carrying out the process, up to the condensation of the motor fuel. The refining of the product may be performed in apparatus which is well known for the purpose and which it is not necessary to illustrate.

In the practice of this process I start with a crude oil or a distillate which may be a "gas oil" of about 0.860 specific gravity or a fuel oil of say 0.950 specific gravity or a low grade lamp oil of about 0.82 specific gravity. In fact the process is adapted to almost any mineral oil and with very slight modifications of operation. This oil is pumped by means of a pump 1 through a coil of 1″ or 1½″ pipe 2 located above a furnace 3 where it is pre-heated by the hot products of combustion arising from the furnace 3. It is then passed through the coil of pipe 4 heated by the burners 5 to an average temperature of from 540° C. to 600° C. according to the oil used, the temperature being determined by a pyrometer 6, th thermo-couple of which is placed in th center of the nest of tubes 4. The temper ture of the gases and vapors inclosed in th tubes may be of somewhat lower temper ture than that existing at the exterior the tube, opposite the same point, varyin with the speed of flow of the fluid in the co and slightly higher at the bottom of th bends and slightly lower at the top. As example, the oil is pumped through this co of tubes at about the rate of 50 to 70 ga lons per hour which rate will be varied wi the quality of the oil used. The length tubing of coil 4 is about 320 feet. The ra of flow and the length of coil mentioned a simply given as examples of rate and leng producing good results; the rate of flow ma be increased or reduced by quite a conside able amount without greatly changing th result. The coil may be increased in leng but if of 1″ pipe could not be reduced muc below the figure mentioned without chan ing the result. The coil 4 may be heate with a flame of gas or by the combustion oil, coal or coke, or in any other suitab manner. In the coil 4 the oil is partial cracked and there is produced a considerab amount of gas which would remain as pe manent gas under ordinary condition From coil 4 the gases and cracked oil in th state of vapor pass in the direction of th arrow through pipe 7 which is fitted with valve 8. This valve 8 is used as the ma throttle and governs the amount of oil pas ing through coil 4 and also governs the pre sure maintained in said coil. A pressure about 75 lbs. per square inch maintained coil 4 appears to give the best results. Aft passing the valve 8 the gases are permitte to expand into the dephlegmator 9 fitted wi an air jacket 10 and preferably filled wi short pieces of pipe or kindred shapes or th like 11 wherein the pressure is decreas from 75 lbs. per square inch (the pressu within the coil 4) down to about 10 lbs. p square inch or less and the temperature reduced down to about 325° C. Carbon thrown out in large quantities by the expa sion of the gases and collects on the filli material in this and the succeeding dephle mator.

The portions of oil not volatile at th temperature of about 325° C. condense dephlegmator 9 and are extracted from th bottom by way of a pipe 12 in the form of so called "heavy residue" of a gravity about 1.0. The more volatile portions pa on through pipe 13 in the direction of th arrow and through a similar dephlegmat 14 where the temperature is reduced to th point where it is desired to make the fin "cut", usually about 180° C., the condensab portion being extracted by way of a pipe from the bottom of the dephlegmator

said residue being termed "light residue." This residue is usually of a gravity of about 0.880 and is used as raw material for a second run through the cracking coil 4. The portion volatile at the temperature of the cut (for example 180° C.) accompanied by all of the gas is then passed through a separating tank 16, (from which any liquid may return by pipe 16ª to dephlegmator 14) or may be otherwise utilized then at its full temperature (that is to say, without any material amount of further cooling) or as near to it as possible the vapors and gases are passed through the cylinder of a mechanical compressor 17 in which the pressure is raised, preferably up to 100 or 125 lbs. per square inch. In the cylinder of this compressor there is produced between the products an endothermic reaction, which is shown by a decrease in temperature at the exit as compared with the inlet or at any rate by a much less increase in temperature than would occur provided no endothermic chemical action took place therein. The product is then passed by way of a pipe 18 to coolers, 19, 20 and thence to a receiver 21, where the liquid collects, and the uncondensed gas finds exit through the pipe 22.

The new product is quite stable and of a yellow color and has a disagreeable varnish-like odor, and contains a material, which upon evaporation of the liquid, remains as a dark orange, non-drying substance, with a strong varnish-like odor. This product accordingly could not well be used as a successful automobile fuel. It is therefore now clarified and rendered water white and its disagreeable odor removed by redistillation without the loss of its large fractions boiling at low temperature and without any substantial change in its specific gravity. This is effected by agitating the spirit with, say about 10% of its weight of fullers' earth or equivalent mineral matter, separating the spirit from the mineral matter and distilling it. I find that although this agitation removes very little of the color (judging by appearances), when distilled the distillate is water white. The coloration and odor may be removed by direct distillation of the spirit from a mixture with fullers' earth or the like or the clarifying of this crude yellow spirit may be effected by treatment with a small amount of sulfuric acid or otherwise.

The step of cooling the gases and vapors produced by cracking oil, while at a pressure materially below that of cracking is not claimed herein, but is claimed in my copending application 852,965 filed July 24, 1914.

The cracking of oil at relatively high temperatures, removing materials having boiling points too high for the production of motor fuel and the subsequent cooling and condensation of motor fuel from the remaining gases and vapors is broadly claimed in my copending applications 824,194 filed March 12, 1914, and 829,634, filed April 4, 1914.

The crude and refined products produced in accordance with the present process and certain modifications thereof are claimed in my copending applications 26,395, filed May 6, 1915, and 26,546 filed May 7, 1915.

The apparatus shown and described herein is claimed in my copending application 77,357, filed February 9, 1916

Having described my invention, what I claim and desire to secure by Letters Patent of the United States is:—

1. The process of forming volatile hydrocarbons, liquid at ordinary temperatures, by subjecting the gases and vapors resulting from the cracking and gasifying of hydrocarbon oils to so great an increase of pressure under substantially adiabatic conditions while the gases and vapors are in a heated state as to produce an endothermic reaction therein, and subsequently condensing the products so formed.

2. Process of producing from mineral oil, liquid fuel suitable for use in automobile engines consisting in subjecting the gases and vapors resulting from the cracking and gasifying of mineral oil to sudden increase of pressure sufficient to produce an endothermic reaction therein, while the gases and vapors are in a heated state, and subsequently condensing the products so formed.

3. Process of producing from mineral oil, liquid fuel suitable for use in automobile engines, consisting in cracking the oil under pressure materially above atmospheric to produce gases and vapors, expanding such gases and vapors, then subjecting such gases and vapors to sudden increase of pressure while the gases are in a heated state, condensing the products so formed and redistilling with mineral matter of the fullers' earth type.

4. Process of producing from mineral oil, liquid fuel suitable for use in automobile engines, consisting in cracking the oil under pressure to produce gases and vapors, expanding such gases and vapors, then subjecting such gases and vapors to sudden increase of pressure sufficient in amount to produce an endothermic reaction therein, while the gases are in a heated state, condensing the products so formed and clarifying the product.

5. Process of producing from mineral oil a liquid fuel suitable for use in automobile engines consisting in cracking an oil under pressure at a high temperature to produce gases and vapors, releasing the pressure of the gases and vapors produced within a short time after their production, passing such gases and vapors through a mass of ma-

terial capable of removing solid materials, and materials having high boiling points, partially cooling the gases and vapors to remove the fractions of high boiling from those of low boiling points, mechanically compressing the partially cooled, but still warm vapors and gas from which the fractions of high boiling points have been separated to attach portions of the gas to the vapors, cooling and condensing the products resulting from the compression under substantially the pressure of compression thereby forming a liquid, removing the portions of gas not affixed to vapor on compression and condensation, and clarifying and deodorizing the liquid product.

6. Process of producing from mineral oil a liquid fuel suitable for use in automobile engines consisting in cracking an oil at a high temperature under pressure to produce gases and vapors, expanding the gases and vapors to deposit solid matter carried by the gases, partially cooling the gases and vapors to remove the fractions boiling at high points, from those boiling at low points mechanically compressing the hot vapors and gas from which the fractions boiling at high points have been extracted to attach portions of the gas to the vapors formed, cooling and condensing the products resulting from the compression under substantially the pressure of compression thereby forming a liquid, removing the portions of gas not affixed to vapor during the compression and condensation and clarifying and deodorizing the liquid product.

7. Process of producing from mineral oil a liquid fuel suitable for use in automobile engines consisting in cracking an oil at a high temperature under pressure to produce gases and vapors, releasing the pressure of the gases and vapors produced immediately subsequent to their production, passing the gases and vapors through a dephlegmator to remove the fractions boiling at high points from those boiling at low points, mechanically compressing the warm vapors and gas from which the fractions boiling at high points have been extracted to attach portions of the gas to the vapor formed, cooling and condensing the products resulting from the compression under substantially the pressure of compression thereby forming a liquid, removing the portions of gas not affixed to vapor on compression and condensation, and clarifying and deodorizing the liquid product.

8. Process of producing from mineral oil a liquid fuel suitable for use in automobile engines consisting in cracking an oil under a pressure of about 70 lbs. per square inch, at a temperature of from about 540° C. to 600° C. to produce gases and vapors, releasing the pressure of the gases and vapors produced immediately subsequent to their production, passing such gases and vapors through a material on which any free carbon carried by the gases will deposit, partially condensing the gases and vapors to remove the fractions boiling at high points from those boiling at low points, mechanically compressing the portions boiling at the lower temperature along with the gas to a pressure of not less than about 125 lbs. per square inch the hot vapors and gas from which the fractions boiling at high points have been extracted, to attach portions of the gas to the vapor formed, cooling and condensing the products resulting from the compression under substantially the pressure of compression whereby to form a liquid, removing the portions of gas not chemically affixed to vapor on compression and condensation, and clarifying and deodorizing the liquid product.

9. Process of producing from mineral oil a liquid fuel suitable for use in automobile engines consisting in subjecting the oil to a high temperature and a moderate pressure to produce cracking, extracting the high boiling point fractions from the cracked products, compressing the remainder of the product while in the vapor and gaseous state sufficiently to produce an endothermic reaction between such gas and vapor, and clarifying and deodorizing the product by distillation with mineral matter.

10. In the cracking of oil and the production of motor spirit therefrom, the step of subjecting the warm vapors and gases to a sufficient increase of pressure to effect a lowering of temperature therein.

11. The step of producing, by substantially adiabatic compression of the gases and vapors produced by cracking oils an endothermic chemical reaction therein.

12. In the process of producing motor fuel from hydrocarbon oils, the step of cracking the oils, and thereafter subjecting at least a portion of the gases and vapors produced therefrom, to a sufficient increase in pressure, to produce an endothermic chemical reaction therein.

13. A process of producing from mineral oil, a liquid fuel suitable for use in internal combustion engines, consisting in cracking the oil under pressure to produce gases and vapors, expanding said gases and vapors and thereafter subjecting said gases and vapors to an increase in pressure, sufficient to produce an endothermic reaction therein.

14. A process of producing from mineral oil, a liquid fuel suitable for use in automobile engines, which comprises cracking mineral oil under pressure to produce gases, light vapors and heavy vapors, partially cooling said gases and vapors, and thereafter subjecting the uncondensed portion thereof to an increase in pressure sufficient

to produce an endothermic reaction in said gases and vapors.

15. In the manufacture of motor fuel the step of adiabatically compressing a mixture of hydrocarbon vapors and gases sufficiently to produce an endothermic chemical reaction therein.

16. A process of forming volatile hydrocarbons, which comprises subjecting the gases and vapors resulting from the cracking and gasifying of hydrocarbon oils, to so great an increase of pressure, without heating or cooling the said gases and vapors from the outside, to any substantial amount, and while the gases and vapors are in a heated state, as to produce an endothermic reaction therein, and subsequently condensing the products so formed.

17. In the production of motor fuel, the step of subjecting gases and vapors produced by cracking oils, to so great an increase of pressure while at a temperature materially below 325° C., as to produce an endothermic reaction therein.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM AUGUSTUS HALL

Witnesses:
R. WILLIAMS,
H. D. JAMESON.

3208

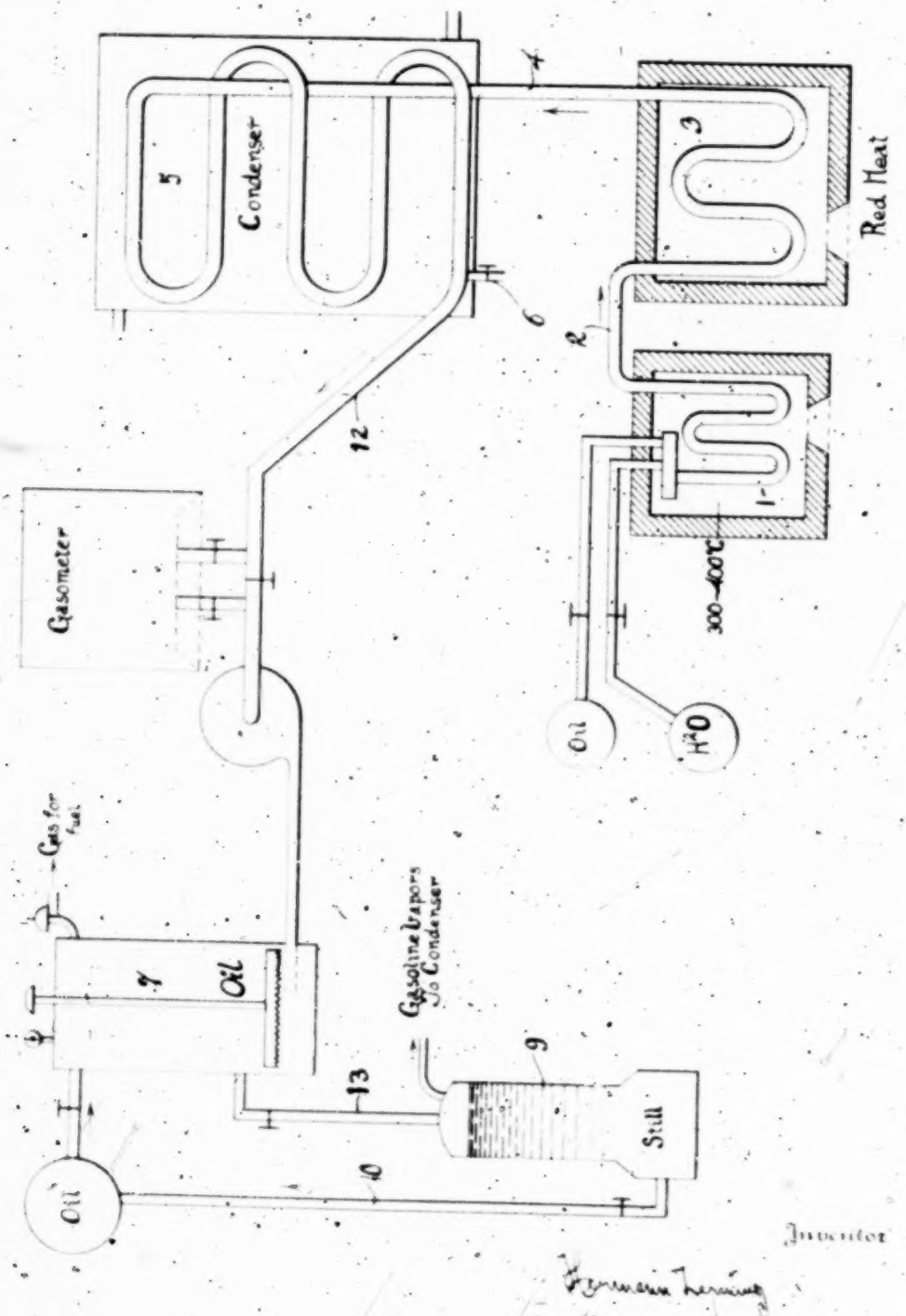
H. ZERNING.

PROCESS OF OBTAINING GASOLENE SUBSTITUTE.

APPLICATION FILED JAN. 20, 1913.

1,183,266.

Patented May 16, 1916.



Inventor

Witnesses

UNITED STATES PATENT OFFICE.

HERMANN ZERNING, OF HALENSEE, GERMANY.

PROCESS OF OBTAINING GASOLENE SUBSTITUTE.

1,183,266. Specification of Letters Patent. Patented May 16, 1916.

Application filed January 20, 1913. Serial No. 743,147.

To all whom it may concern:

Be it known that I, HERMANN ZERNING, a subject of the German Emperor, and resident of Halensee, Germany, have invented certain new and useful Improvements in Processes of Obtaining Gasolene Substitute, of which the following is the specification.

The present invention relates to a process of converting mineral oils, and other hydrocarbons, into a more readily vaporizable or more volatile material, in order to produce a gasolene substitute therefrom, which gasolene substitute will be capable of use directly in internal combustion engines.

In the following description I use the term "hydrocarbon" to designate mineral oils, petroleum, shale oil, schist oil, as well as distillates thereof, and the like.

My improved process comprises the step of absorbing certain vapors or gases resulting from the decomposition (cracking) of hydrocarbons, of the kinds above stated, in oils of higher boiling points. Such absorption may be effected under more or less pressure, and is preferably continued until the hydrocarbons are fully saturated with the stated gases or vapors. The product of this process has a flashing point lower than that of the original oil.

Gases suitable for use in treating ordinary petroleum, and which will be readily absorbed thereby, may be obtained by decomposing petroleum or other heavy hydrocarbons, preferably in the presence of a suitable catalytic body, for instance water, which is the cheapest of all suitable catalytic materials. This treatment will be carried out at a comparatively high temperature, for example a mixture of water and the hydrocarbon, preferably in the proportion of 1 part of water for every 6 to 10 parts of the oil, is forced under sufficient pressure, into or through a still heated to a temperature of 300 to 400° C. The vapors thus evolved are conveyed through pipes heated to a dark red, then through cooling coils, in which the separation of water, heavy oil, and tarry matters from the uncondensed gases is effected, which gases are then directly introduced into the hydrocarbon oils under treatment, or preferably are collected in a gas holder, for being so employed later on. The pipes in which the second heating step is carried out, are preferably steel pipes protected from overheating by a layer of fire-clay, or other suitable material. The treatment of the petroleum or the like with the stated gases is preferably carried on under considerable pressure, in order to accelerate the absorption of the gases. Thereafter the material may be subjected to partial distillation and that fraction which passes over at or below the usual distilling temperature of ordinary gasolene, forms the gasolene substitute in accordance with the present process, and the liquid remaining in the still may be again subjected to the action of the described gases, after cooling, or may be subjected to the cracking operation.

In the accompanying drawing I have shown diagrammatically an apparatus for carrying out the process of the present invention, although obviously the invention is not limited to the use of such particular apparatus.

As a specific example of carrying out my process, the following is given. A suitable vessel (being preferably in the form of a steel pipe 1 surrounded with fire clay or the like, to prevent overheating of the oil) is heated, and a mixture of petroleum and water in the proportion of 8 parts of petroleum to 1 part of water (more or less) is passed through said pipe, at a rate of speed, such that the mixture of petroleum and water leaves the coil of pipe (of which there may be one or several) at a temperature of about 300° C. to 400° C. The resulting steam and vapors are conveyed through pipe 2 to a superheating arrangement composed of pipes 3, heated to incandescence, or preferably to a dull redness, say 700° C., the rate of passage of the vapors depending upon the temperature of the pipes, and also more or less upon the character of the petroleum employed, and upon the proportions of petroleum and water. Care must be taken not to pass the gases too slowly, since this would produce too complete a decomposition, which would lead to the formation of considerable quantities of free carbon, and consequently would produce an unsatisfactory result, both as to the yield and the character of the gases and vapors. The gases and vapors are then carried through pipe 4 and a condenser 5 in which the water, heavy oil and tarry substances are condensed and the condensate drawn off through pipe 6 from the uncondensed gases, which gases are preferably conveyed through pipe 12 into a gasometer or stor-

age receptacle. From said storage receptacle, (or, less advantageously, from the condenser directly) the gases are conveyed into and through one or several receptacles 7 containing hydrocarbon oil, such as petroleum, under pressure and at ordinary temperature. The minimum strength of such receptacles will depend upon the amount of pressure to be employed therein, and in case the gases are conveyed, directly from the condenser into and through these receptacles, the pressure employed should not be too high, since this would cause too slow a passage of the gases through the superheating coil, and accordingly produce too much decomposition therein. After passing through the petroleum or other oil in the one or several receptacles 7, the unabsorbed gases may be used as fuel.

The material in the receptacles is very different from the starting material, such as petroleum or other oil previously placed therein, and under some circumstances may be used directly as a substitute for gasolene. The specific gravity of said material is lower than that of the starting material, it has also considerably increased in volume, and the flash point is very much lower. For instance in a particular experiment the gases from the cracking of petroleum as above described were directly introduced under a pressure of about 1 atmosphere (above normal) into crude petroleum of which the specific gravity was .794, its flash point being that of ordinary petroleum. The resulting material was a hydrocarbon spirit having a specific gravity of .775, and a flash point of about 10° C. With higher pressure in the absorption receptacles, these figures were more satisfactory. This material is preferably led through pipe 13, into the still 9, where it is then subjected to fractional distillation and the portion which volatilizes at a comparatively low temperature may be separately condensed, forming a gasolene substitute, which is very suitable for use in internal combustion engines or the like. The portion which is less volatile than this gasolene fraction being pumped up through pipe 10, to the oil reservoir, and after cooling may be again subjected to treatment with a further quantity of the above described gases. The exact temperature at which the collection of the gasolene substitute will preferably be stopped can not be generally stated, for the reason that this depends upon a number of conditions, such as the particular grade of mineral oil employed, the temperature and pressure used in the absorption step, and the temperature used in the cracking of the mixture of oil and water.

What I claim is:—

1. A process of making a gasolene substitute which comprises cracking hydrocarbon oils by heating the same in the presence of a catalytic agent, to a temperature of 300 to 400° C., then passing the vapors thereby produced through a conduit heated to dark redness, and then cooling the gases and vapors sufficiently to separate water, and materials of high boiling points therefrom, then passing the remaining gases into contact with a heavy hydrocarbon oil under pressure, until said oil becomes substantially saturated.

2. A process of making a gasolene substitute which comprises cracking hydrocarbon oils by heating the same in the presence of a catalytic agent, to a temperature of 300 to 400° C., then passing the vapors thereby produced through a conduit heated to dark redness, and cooling the gases and vapors sufficiently to separate water and materials of high boiling points, then passing the remaining gases into contact with a heavy hydrocarbon oil under pressure, until said oil becomes substantially saturated and finally distilling off a fraction corresponding to the boiling point range of ordinary gasolene.

3. A process of converting mineral oils and other hydrocarbons into substances having lower boiling points, said process comprising the steps of introducing oil and water into a retort heated to a temperature of about 300° C., allowing the resulting gases and vapors to freely escape from said retort, conveying said gases and vapors into a second retort, in which they are heated to a higher temperature, cooling said gases and vapors sufficiently to remove water and materials having high boiling points, and thereafter passing the cooled gases into contact with a relatively heavy hydrocarbon oil under pressure, until said oil becomes substantially saturated.

In testimony whereof I have hereunto set my hand in presence of two witnesses.

HERMANN ZERNING.

Witnesses:
ALBERT HÖFMANN,
Dr. PAUL HOLLEFREUND.

3212

W. A. HALL.

PROCESS OF CRACKING HYDROCARBONS.

APPLICATION FILED MAR. 21, 1916.

1,194,289. Patented Aug. 8, 1916.

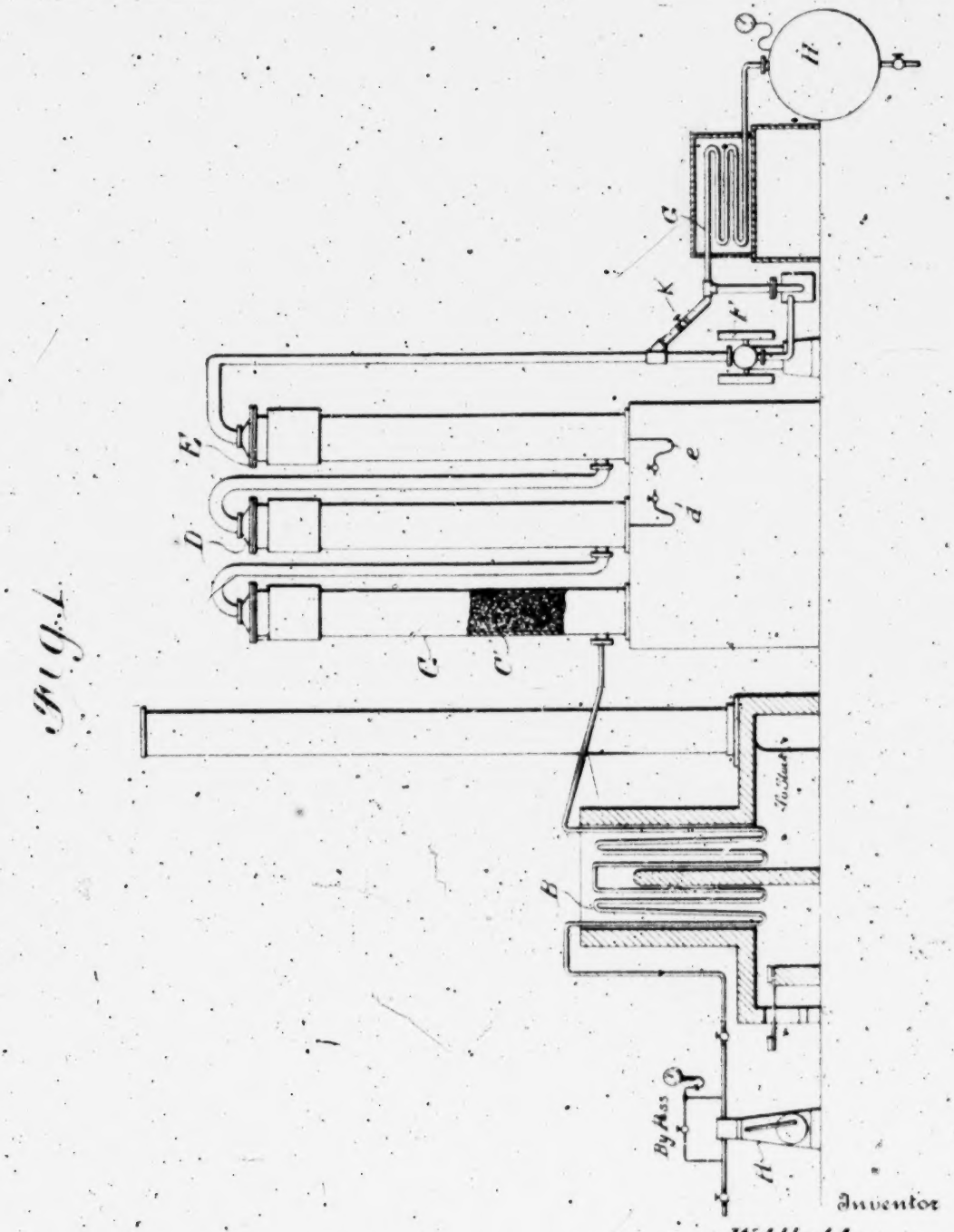


Fig. 1.

Inventor
W. A. Hall.

Witness
J. H. Crawford

By A. B. Foster, Attorney

UNITED STATES PATENT OFFICE.

WILLIAM AUGUSTUS HALL, OF NEW YORK, N. Y.

PROCESS OF CRACKING HYDROCARBONS.

1,194,289. Specification of Letters Patent. Patented Aug. 8, 1916.

Application filed March 21, 1916. Serial No. 85,735.

To all whom it may concern:

Be it known that I, WILLIAM A. HALL, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Processes of Cracking Hydrocarbons, of which the following is a specification.

This invention relates to the cracking of oils for their subsequent conversion into motor spirit or into members of the aromatic series such as benzene, toluene and xylene, and has for its object to provide an improved process of cracking such oils to obtain a more uniform cracking of the oil than was hitherto possible, and with the consequent production of less permanent gas and a consequent saving in fuel.

Broadly, the improved process of cracking consists in subjecting the oil to a partial cracking by forcing it under pressure at a high speed of flow through small tubes heated to a sufficiently high temperature to produce this partial cracking, the oil being vaporized to such an extent that the speed of flow of the vapors and gases through the tubes is increased very largely, and then, preferably while they are no longer subjected to such external heating, suddenly reducing the velocity of such vapors and gases very largely thereby transforming substantially all of the energy in the form of velocity, save the initial velocity, into additional heat of a superheating character which completes the cracking operation without converting the vapors into permanent gas.

In carrying the invention into effect I pass the oil at a high speed of flow through small tubes of approximately one inch diameter under a pressure of approximately 75 lbs. (or more) per square inch and at a temperature of the vapors inside the pipe of from 550° C. to say 700° C. depending upon the product to be obtained and the oil treated, the oil being vaporized in the tubing to such an extent that the speed of the vapors becomes from 5000 feet per minute upward, the amount of feed being so large and the temperature so low that only a partial cracking into gasolene-like material is effected in these tubes, the great speed of flow and incomplete cracking preventing any material deposit of carbonaceous matter in the tubes. The gases and vapors are then expanded into a much larger tube, say of from 12" to 16" in diameter (and which may be 8 to 11 feet in height) in one or more stages, being preferably caused to impinge against suitable baffles or filling in order to suddenly reduce the velocity to an enormous extent, thereby transforming the mechanical energy of the gases and vapors in the form of velocity into additional heat, the temperature of the vapors and gases in the large tube being thereby raised without any extraneous heat being applied, the cracking operation being thus completed in this large tube. As the walls of this large tube are cooler than the center of the mass of vapors passing into the same not much decomposition of the vapors into permanent gas takes place in this large tube.

The product of the cracking operation if it is to be converted into motor spirit may be treated for intsance as described in my U. S. Patent No. 1,175,910. In said patent, as well as in applications for Letters Patent Serial Nos. 824,194, 829,634 I have claimed the production of motor fuel by steps described in the present application. In converting the product of the cracking operation into hydrocarbons of the aromatic series a compressor such as that shown in the accompanying drawing is not necessary. Compression without the compressor is created in the tubes of the converter by the expansion of the gases and such compression is fully as high as the pressure created subsequently by the compressor. In producing motor spirit such compressor is required as without it there is not obtained in the final product a sufficient amount of low boiling fractions. In treating the oil for the purpose of conversion into members of the aromatic series, the oil in the tube constituting the decomposing retort or "converter" is subjected to a higher temperature than in the production of motor fuel, say a temperature of about 650° C. to 700° C. and a correspondingly higher pressure is produced. This temperature of course depends to some extent on the character of the oil treated, easily cracking oils such as those of Mexico, California and Persia requiring lower temperatures to obtain the same results than the more difficultly cracking oils like Pennsylvania kerosene. It will be clear that in operating at the high temperatures there will be no need for a throttle valve such as that beyond the converter in the said prior patent since the necessary pressure of 75 lbs. and above is obtained entirely from the

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amount of oil fed in and the expansion of the vapors. I find that when running at say about 700° C. and feeding the oil at the rate of 90 gallons per hour through a 1" pipe, the expansion is so great that I obtain the desired pressure without any throttling.

Naturally in practising the process for the conversion into aromatics there is produced much more fixed gas than is produced when the process is operated for the production of motor spirit, on account of the higher temperature used in the production of aromatics. The product produced does not consist entirely of members of the aromatic series, and subsequent distillation to separate the benzene, toluene and xylene from the paraffins (or other treatment to secure this result) is necessary.

By only partially cracking the oil in the heated tubes and by producing a rise in temperature and effecting as large an amount of the cracking as possible beyond the influence of external heat, the production of large amounts of fixed gas, (which are of course of a less value than the condensable spirit) is largely prevented. If the cracking were all done in the heated tubes (on the same total yield of spirit), the permanent gas produced would be much greater than is produced when a considerable amount of, (and the completion of) the cracking is effected at a point beyond the influence of the external heat. The light vapors never being exposed to a higher temperature than that of their production are not decomposed into fixed gas by superheating, and are collected as a condensate along with the other condensable portions, thereby greatly increasing the yield of spirit, this increase practically all being in the very low boiling fractions (lighter fractions).

It will be seen that the mechanical energy in the form of velocity of the gases is largely converted into heat which superheats the whole in a somewhat similar manner to that in which steam is superheated in a throttling calorimeter.

Apparatus suitable for performing the process is illustrated somewhat diagrammatically in the accompanying drawings in elevation, partly in vertical section.

In the drawing, A denotes a pump which is operated at a speed suitable for forcing the oil to be treated at a high rate of flow into a converter B heated in the same manner as in my patent above noted, to a temperature suited to produce partial cracking of the oil and under a pressure of 50 to 75 lbs. (or more) per square inch. The vapors and gases produced in the converter B, by reason partly of the expansion produced, pass at a very high speed into a very much larger vertical pipe or column C where the pressure falls to 1 or 2 lbs. per square inch, this column being provided with baffles or suitable filling material for reducing the velocity of the vapors and gases suddenly to a very large extent. This velocity is thereby converted into additional heat which superheats the vapors and gases and thereby completes the cracking operation. The vapors and gases are then led through dephlegmators D and E from which the heavy and light residues are removed by way of pipes *d* and *e* and thence (in the production of motor fuel) to a compressor F and compressed for example to about 125 pounds per square inch, and pass under about this pressure, into a condenser G from which they are taken to a receiving tank H. In the production of aromatics, the vapors and gases from E pass directly to the condenser G, through the valved pipe K.

What I claim is:—

1. A process of cracking an oil consisting largely of fractions having higher boiling points than ordinary gasolene, which comprises passing said oil at a rate of flow sufficient to prevent deposition of any material amount of free carbon, through a pipe under a pressure materially above atmospheric, while at a temperature sufficient to vaporize the said oil and to only partially crack the same into products having a boiling point range suitable for use directly as gasolene, then suddenly introducing the products of the partial cracking step while discontinuing the external heating, into a separate receptacle and against obstructions therein, under conditions capable of converting a material proportion of the energy of velocity into heat, and thereby developing, within the gases and vapors, a sufficient amount of heat to effect a further cracking of the said vapors.

2. In the process of cracking oils, the step of suddenly converting into heat, a portion of the energy represented by the velocity of a rapidly flowing mixture of gases and vapors of cracked hydrocarbons, a part only of which have a suitable boiling point range for use directly as gasolene, by directing said rapidly flowing mixture against obstructions, whereby the temperature is raised and a further cracking is effected.

3. In the cracking of oil, the step of passing the hydrocarbon oil rapidly through a coil at an elevated temperature and under a superatmospheric pressure suitable to produce some cracking and to leave a mixture consisting essentially of vapors and gases, and then raising the temperature of the said vapors and gases sufficiently to further crack the said vapors, while avoiding the application of external heat during said second heating step.

4. A process of cracking oil for the production of motor fuel or of products containing members of the aromatic series, such as benzene, toluene, xylene, which comprises

the successive steps of forcing the oil at a high rate of flow through tubes heated to a temperature below the desired cracking temperature and under a pressure materially above atmospheric, but low enough to permit vaporization of the bulk of the oil, and thereafter directing the rapidly flowing current of vapors and gases against obstructions, while suddenly reducing the velocity of the vapors and gases, and thereby raising the temperature thereof by heat generated therein, substantially as and for the purpose described.

5. A process of cracking oil which comprises forcing the oil at a high rate of flow, under pressure materially above atmospheric through a tubular retort heated to a temperature sufficient to produce a mixture of vapors and gases containing some cracked hydrocarbons of a lower boiling point range than the original oil employed, and suddenly directing the rapidly flowing mixture of vapors and gases against obstructions while reducing the velocity of the vapors and gases produced and thereby raising the temperature thereof, to produce the desired amount of cracking.

6. A process of cracking oil which includes the step of first effecting a partial cracking by subjecting the vapors of said oil, while flowing at a high rate of speed under a pressure of several atmospheres, through a decomposing retort heated to a temperature below that necessary for producing the completion of the desired cracking operation, and then further raising the temperature of said vapors, without the application of any external heat, by converting into heat, a portion of the energy represented by the velocity of the vapors and gases, whereby the completion of the desired cracking operation is effected.

7. A process of cracking oils for the production of motor spirit or of members of the aromatic series such as benzene, toluene and xylene consisting in forcing the oil through a pipe under a pressure of not materially less than about 75 lbs. per square inch at a temperature inside the pipe of from 550° C. to about 700° C. to produce a velocity of vapors of not less than about 5000 feet per minute, and expanding the vapors and gases into a much larger pipe, containing obstructions.

8. A process of cracking oils for the production of motor spirit or of members of the aromatic series such as benzene, toluene and xylene consisting in forcing the oil through a pipe under a pressure of not materially less than about 75 lbs. per square inch at a temperature inside the pipe of from 550° C. to about 700° C. to produce a velocity of vapors of not less than about 5000 feet per minute, and thereafter further heating the said vapors by directing the same against obstructions and quickly reducing the speed of flow thereof.

9. A process of cracking oil consisting essentially of fractions which have higher boiling points than ordinary gasolene, which comprises passing said oil at a rate of flow sufficient to prevent deposition of material amounts of free carbon, through a pipe under a pressure materially above atmospheric, but sufficiently low to allow vaporization of said oil, while at a temperature sufficient to only partially crack said oil into products having a boiling point range suitable for use as gasolene, then suddenly introducing the products of said partial cracking step, while discontinuing external heating, into a separate receptacle, and against obstructions therein, and raising the temperature of the gases and vapors by heat developed by the impingement of the said gases and vapors against said obstructions, to effect a further cracking of the said vapors.

10. The process of converting hydrocarbon oils which comprises subjecting a rapidly flowing current of oil vapor, while under a pressure materially above atmospheric, to a temperature sufficient to only partially crack the same into products having the boiling point range of ordinary gasolene, then lowering the pressure and speed of flow and simultaneously raising the temperature of the same by causing the vapors to impinge upon a baffle to effect a further amount of cracking.

11. A process of cracking an oil having higher boiling points than ordinary gasolene, which comprises passing said oil at a rate of flow sufficient to prevent deposition of any material amount of free carbon, through a pipe while under a pressure sufficient to prevent the conversion of excessive quantities of the oil into fixed gases, while at a temperature sufficient to vaporize said oil and to only partially crack the same into products having a boiling point range suitable for use as gasolene, then further raising the temperature of the vaporized and partially cracked oil, by causing the said vapors to enter a separate receptacle and to impinge against obstructions therein, and to thereby raise the temperature of the said vapors sufficient to further crack said vapors.

In testimony whereof I affix my signature.

WILLIAM AUGUSTUS HALL.

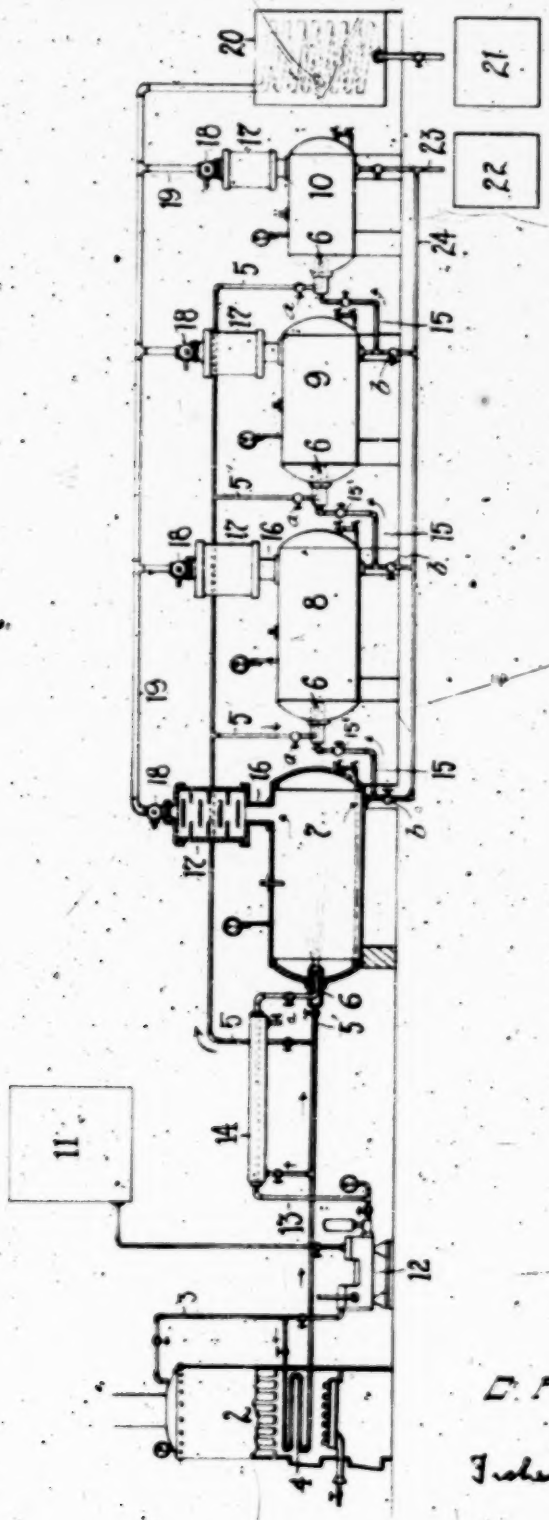
3216

C. FORWARD.

PROCESS OF REDUCING CRUDE PETROLEUM.

APPLICATION FILED MAR. 23, 1916.

1,202,823. Patented Oct. 31, 1916.



WITNESS

Geo. C. Kramer

INVENTOR

C. FORWARD.

BY

Fisher Russell

ATTORNEYS

UNITED STATES PATENT OFFICE.

CHAUNCEY FORWARD, OF URBANA, OHIO.

PROCESS OF REDUCING CRUDE PETROLEUM.

1,202,823. Specification of Letters Patent. Patented Oct. 31, 1916.

Application filed March 23, 1916. Serial No. 86,057.

To all whom it may concern:

Be it known that I, CHAUNCEY FORWARD, a citizen of the United States, residing at Urbana, in the county of Champaign and State of Ohio, have invented certain new and useful Improvements in Processes of Reducing Crude Petroleum, of which the following is a specification.

This invention relates to a process of reducing crude petroleum and its residua to a light volatile oil suitable for use in internal combustion engines or any other purpose for which such an oil can be used, and is an improvement upon the process of treating crude petroleum set forth in my application for Letters-Patent of the United States, filed May 24, 1915, Ser. No. 29,996, Patent No. 1,189,083 of June 27, 1916, the object being to obtain a materially increased amount of volatile oil in a more practical and economical way than in said first process and any other process known to me.

In the accompanying drawing the single figure shown is a diagrammatic view of one form of an apparatus for practising my improved process, said apparatus consisting of a steam boiler 2 having a steam delivery pipe 3 leading to a steam superheater 4 from which the superheated steam is delivered under high pressures from 50 pounds upward to the square inch through pipe 5, and several branch pipes 5′ into suitable oil injectors or atomizers 6 located in the front ends of a series of seperators 7, 8, 9 and 10. While I prefer to use steam in practising the process, I might employ air and use apparatus for heating and delivering the air at the desired working temperatures and pressures.

The crude oil is taken from a storage tank 11 and forced by a steam pump 12 under a high pressure into the first separator 7 by way of a pipe 13 connected with the atomizer 6 of said separator, and a heater 14 of jacket form is connected with the superheated steam and surrounds a portion of the oil delivery pipe 13. Each separator has a discharge pipe 15 for the residuum precipitated therein during operations, and the discharge pipe 15 from the first separator 7 leads to and delivers the residuum to the atomizer 6 of the second separator 8 in the series, while the discharge pipe 15 for separator 8 delivers the residuum of that particular separator to the atomizer 6 of the next separator 9 in the series, and so on dependent upon the number of such separators used. Each separator in the series has a separate vapor discharge connection 16 and a clarifier 17 at its top; also a pressure-regulating valve 18 in the branches or lines of pipe 19 leading to a single condenser 20, although a series of separate condensers might be used if desired. Separate receptacles 21 and 22 may be used to receive the volatile oil from condenser 20 and the residual discharge from the pipe 23 of the last separator 10, and a common blow-off pipe connection 24 is also provided for all of the separators so that one or more may be operated or cleaned out at will. The various steam and oil pipe connections are provided with suitable valves wherever needed to control the flow of steam and oil for and during operations.

In practising the process, the crude oil is forced by pump 12 into the first separator 7 together with superheated steam, the oil being also preferably heated initially by heater 14. The superheated steam is delivered under sufficient pressure to atomize the oil effectively as it enters the separator, and such introduction of the atomized oil proceeds continuously while the temperature in separator 7 is maintained at about 400 degrees F. or higher. A constant pressure is also maintained within the separator, but of course not in excess of the pressure of the steam entering through the atomizer 6, and the separators are covered with suitable insulation to avoid radiation of heat. The pressure in the separator is maintained by the pressure-regulating valve 18 above the clarifier 17 which only opens to permit the vapors to escape when a predetermined pressure is exceeded and because the outflow of the residual through pipe 15 to the next separator 8 is restricted and controlled by a valve 15′. The vapors thus obtained pass over pipe 19 to the condenser 20, and the volume or quantity of volatile oil so obtained from the crude oil is greater than by any other method known to me, while the flow of oil and steam thereinto and the vapors and residuum therefrom is continuous. However, I have discovered that this amount of volatile oil may be greatly increased in an economical and practical way by treating the residue of the first separator in substantially the same manner as the oil delivered

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to said first separator, using a second separator 8 but without refiring operations, loss of time, extra labor, or resorting to further pumping and heating of the oil or residuum; and that further material reductions of the residual discharges from the second separator and still other separators will yield still greater percentages of volatile oil until the yield of volatile oil to any amount of hydro-carbon oil is exceedingly high and the cost of reduction relatively low. Specifically, these supplemental steps consist in forcing the residuum of the first separator 7 into the second separator 8 in an atomized condition under the controlled pressure maintained in the chamber of said first separator 7 and before said residuum has cooled. In fact, this residuum is delivered extremely hot as obviously it must be in view of its constant exposure to the temperature of about four hundred degrees F. or higher which is maintained in said first separator. If desired, the steam and oil vapors in separator 7 may be permitted to commingle more or less with the residuum as it is delivered to the atomizer 6 of the second separator 8 in the series. The discharge into the second chamber is under a sustained pressure, and there is a continuous intermixture of the inflowing residuum with a fresh supply of superheated steam furnished to the atomizer 6 of the second separator 8 by branch pipe 5'. In this way, a similar high temperature is maintained in the second separator as in the first, and the vapor pressure in the chamber of the second separator is maintained at a slightly reduced working pressure compared with the first by the use of the pressure regulating valve 18 and the valved control at the residual discharge pipe 15. The vapors within the second separator 8 are clarified and discharged through the clarifier 17 and the line of pipe 19 connected with the condenser 20, thereby increasing the original output of volatile oil to a large extent. However, the residuum in the second separator 8 is capable of further reduction, that is, the residuum may be reduced and additional percentages of volatile oil obtained by repeating the foregoing steps and using similar separators connected in the same line of pressure and without resorting to re-firing or other expensive and prolonged modes of operation. When these steps are carried out to their fullest extent within practicable and commercial limits, the percentage of volatile oil to crude oil is far beyond what has heretofore been possible of accomplishment commercially.

In practice, the vapor pressure in each successive separator decreases somewhat, but the temperatures may be readily controlled so as to be substantially uniform from start to finish, or higher temperatures might be employed during the final separations. The separators may be of the same size throughout, but I prefer to use separators graduated in size to better promote operations.

Suitable hand operated valves are employed here and there in the several oil and steam supply pipes as the service may require and by which flow through said pipe can be regulated or controlled, and the location of such valves is preferably according to convenience of approach in a given plant. For example, the branch pipes 5' have control valves *a* to govern the flow of steam to the atomizers, and the down pipes for the residuum from the separators have control or cut off valves *b* below the connection 15 which go to the next separator. Thus, the outflow of the residuum is restricted and requires the force behind it in the preceding chamber to carry the residuum forward into the next chamber. Of course a predetermined working pressure in all the chambers would be impossible without control of the inlets and the outlets.

The separating or decomposing chambers herein are preferably arranged in a row, as shown, with the residual products from a given chamber flowing under pressure from the bottom thereof to the end of the next chamber and where the residuum is atomized openly into the body of the chamber in the presence of the maintained pressure therein, which may be fifty pounds to the square inch and upward. Hence, also, the importance of artificial or mechanical pressure behind the oil, as by pump 12 to force the oil into the chamber against the pressure therein. The separating chambers being individual and exposed to the open air, and without external heat, I find it advantageous to cover them heavily with asbestos or the like to prevent undue radiation. It is my aim to have substantially the same separating conditions in all the chambers, and since both heat and pressure which come over from a given chamber are more or less diminished in transit the difference can be practically made up by superheated steam forced in through the branch pipes 5' to the atomizers 6 and in which operation the residuum is exposed to the steam under the most favorable conditions possible for atomization and recovery of the contained oil vapors.

The apparatus shown in this application is embodied in my application Serial No. 121,933, filed September 25, 1916.

What I claim is:

The process herein described of decomposing and separating hydro-carbon oils, consisting, first, in atomizing the oil under pressure by superheating vapors under pressure into a suitable chamber in which a uniform pressure of fifty pounds and upward, and uniform temperature of about 400 degrees F. and upward is maintained exclusively by the injected vapors and thereby separating

the volatile from the residual oil products, and then drawing off both products separately under such control as to each product as will govern the flow and sustain substantially the pressure and temperature in said chamber above specified; and then, as a continued step in the complete process, forcing the said residual products into a succeeding chamber by the pressure stored in said first chamber and at the same time injecting superheated vapor into the residuum between the chambers in sufficient volume to thoroughly atomize the said residual products and to bring the temperature and pressure in said succeeding chamber to approximately the separating conditions obtained in the first named chamber to volatilize another portion of lighter oils from said residual oil products, and continuing the process through other succeeding chambers.

In testimony whereof I affix my signature in presence of two witnesses.

CHAUNCEY FORWARD.

Witnesses:

Geo. E. Knickm

R. B. Mosm.

3224

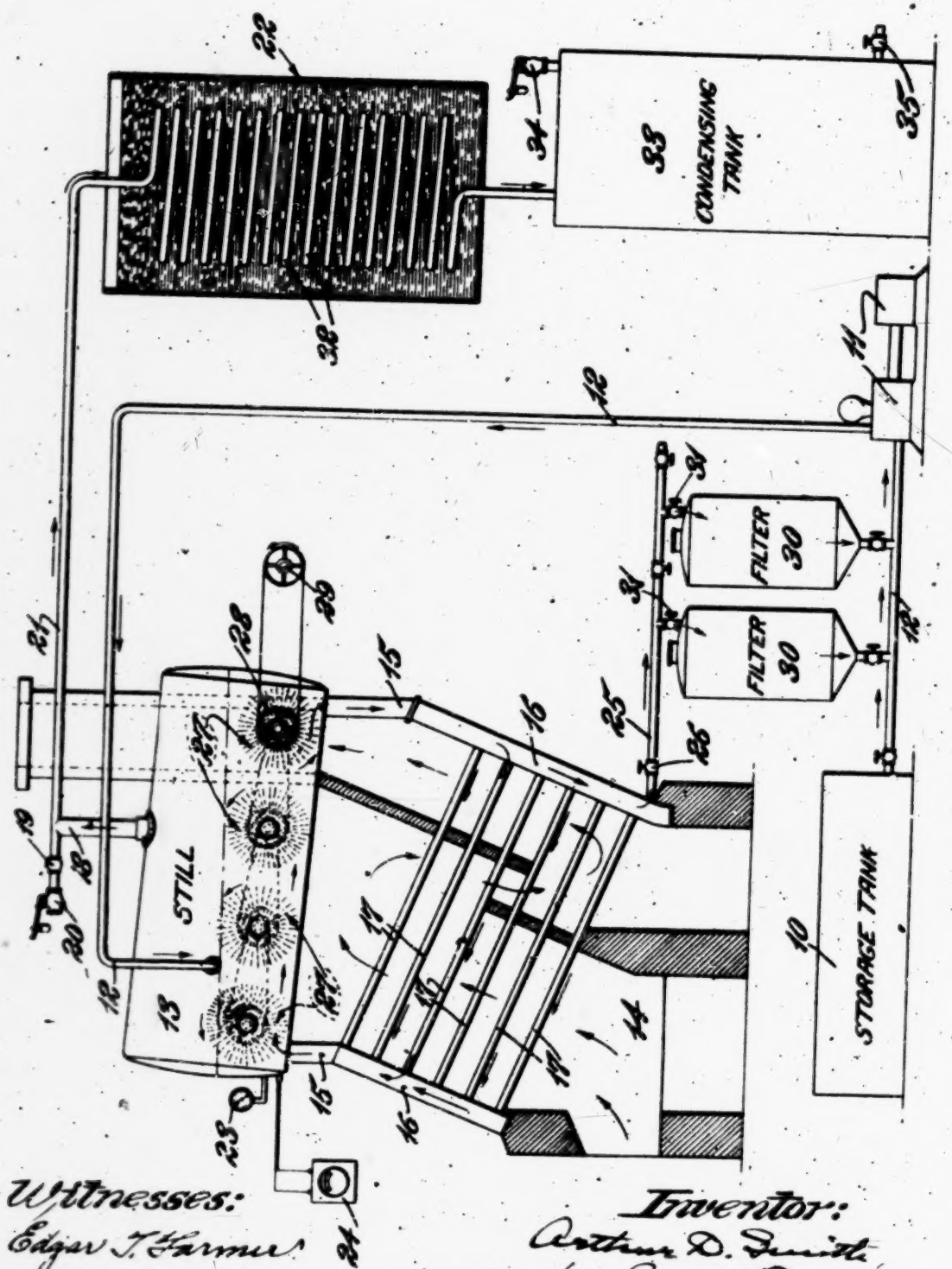
A. D. SMITH.

MANUFACTURE OF GASOLENE.

APPLICATION FILED APR. 28, 1915.

1,239,423.

Patented Sept. 4, 1917.



Witnesses:
Edgar J. Farmer
Allen Holcombe

Inventor:
Arthur D. Smith
by Cameron & Cameron
his attys.

UNITED STATES PATENT OFFICE.

ARTHUR D. SMITH, OF VINITA, OKLAHOMA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JOHN T. MILLIKEN, OF ST. LOUIS, MISSOURI.

MANUFACTURE OF GASOLENE.

1,239,423. Specification of Letters Patent. Patented Sept. 4, 1917.

Application filed April 28, 1915. Serial No. 24,415.

To all whom it may concern:

Be it known that I, ARTHUR D. SMITH, a citizen of the United States, residing at Vinita, in the county of Craig, State of Oklahoma, have invented a new and useful Improvement in the Manufacture of Gasolene, of which the following is a specification.

My invention relates to certain improvements in the method of destructive distillation of higher boiling point compounds of petroleum and particularly distillates known to the trade as fuel oil or gas oil, having a boiling point of 500° F. and upward.

A known method is to subject the aforesaid fuel oil, gas oil or distillate of a paraffin group ~~to a temperature~~ of 650° F. to 850° F. in a closed vessel under 4 to 5 atmospheres pressure, maintaining said pressures on vapor evolved during distillation throughout their course to and while undergoing condensation.

This method has serious drawbacks to successful commercial operation due to the deposit of carbon on the heated surfaces of the inclosing vessel so that this aforesaid heated surface becomes red hot with danger of burning out the bottom of the still, the deposit thereby preventing the still running to high efficiency.

My invention deals with a novel method of distillation of the above described fuel oil, gas oil or distillates of paraffin nature at pressure of 125 to 150 pounds and at a temperature of 600° to 700° F., whereby so rapid a circulation is maintained during the process that the objectionable aforesaid carbon deposition on the heating surfaces of the still is greatly reduced and the yield of crude gasolene increased some 70 to 80%, due to ability to prolong the process by removing danger of burning out the heated metal surfaces.

However highly desirable this process, it is evident from the chemical composition of the aforesaid gas oil, fuel oil or distillate, that carbon is continuously formed during the breaking down of compounds of higher to those of lower molecular weight, which carbon, while prevented to a great extent in my process from adhering to the heated surfaces, must eventually bring the process to end if not removed; and my method further provides for removal of this objectionable carbon by sweeping at intervals portions of the charge to suitable interchangeable filters and returning the carbon free fluid to the still together with fresh distillate, the action being thus rendered continuous, a most essential feature as regards increasing the output from a given size of apparatus. By carbon free fluid is meant a liquid from which suspended carbon particles likely to deposit on heated metallic surfaces have been removed.

It has been noted that, however desirable is the method of applying pressure throughout the course of distillation to and while vapors are undergoing condensation, nevertheless a certain constant loss takes place through evaporation of the lighter gasolenes passing from the liquid to gaseous state as the condensate flows from the end of the condensing coil to the receiving tank where it passes from high pressure to atmospheric pressure with great lowering of surface tension; and I have discovered that this aforesaid loss may be reduced from forty to fifty per cent. by keeping not only the vapors themselves under pressure to and while undergoing condensation, but the liquid condensate as well, relieving pressure in excess of 150 pounds only at the storage tank. I allow the latter to nearly fill before removal of contents, and I blend the same immediately with low gravity naphtha, thus entraining and fixing lighter portions of condensate produced under pressure and incorporating these compounds to a large extent a permanent part of the final crude gasolene so that subsequent evaporation is reduced to a minimum. Further details of the invention appear in connection with the following description of the process and apparatus for carrying it out.

A suitable form of apparatus for the practice of my invention is illustrated in the accompanying drawing, which is essentially diagrammatic in character and which represents the apparatus partly in vertical longitudinal section, and partly in side elevation.

Referring to the drawing, the gas oil, fuel oil or paraffin residue is charged from a storage tank 10 by a pump 11, through the pipe line 12 to a boiler or still, which may be of any suitable type. The still shown in the drawing consists of the drum or shell 13 which is mounted in a suitable setting over the furnace 14 with its longitudinal

axis at a slight downward inclination from front to back. Nipples or connections 15 open into the bottom of the shell at its front and back ends and these nipples are connected to the tube boxes or headers 16 which are arranged at the front and back ends of the furnace chamber. A series of parallel tubes 17 connect the headers, and the tubes and headers are arranged at a considerable upward inclination from back to front below the boiler shell in the path of the hot gases from the furnace. The boiler outlet 18 is provided with a vacuum valve 19 and safety valve 20. A vapor line pipe 21 leads from the boiler outlet to the condenser 22. The boiler is also provided with a pressure gage 23 and a thermo-electric pyrometer 24. An outlet pipe 25 for residuum leads from the lower end of the back header 16, and is normally closed by a valve 26. Within the boiler are arranged a series of revolving brushes 27, which may be made of steel wire or other metal capable of withstanding heat and corrosion. The brushes are operatively connected together with driving chains arranged within the boiler, and the rear brush is mounted on a shaft which passes through a stuffing box in the side of the boiler and is provided with a pulley 28 on its outer end. The pulley 28 is belted to a pulley on the line shaft 29 whereby the series of brushes may be rotated at a suitable speed. The brushes are rotated in the direction shown by the arrows in the drawing, thereby assisting in maintaining the circulation in the still, and also sweeping the bottom of the boiler shell free from the carbon which has a tendency to deposit and accumulate therein during the operation of the apparatus. Preferably the drum or shell 13 has a large capacity in proportion to the capacity of the tubes. The angles of inclination of the drum, tubes and other parts of the still are not restricted to those shown in the drawing. The mechanical agitation of the liquid in the drum by the sweeping action of the brushes facilitates rapid circulation and assists in preventing deposition of carbon in the apparatus. It is understood that the arrangement of parts shown in the drawing is only a typical arrangement of one form of still, and that it can be varied according to requirements for proper circulation, type of boiler or still used, or greater or less tendency of the carbon to deposit. Any suitable arrangement of brushes may be used to assist circulation and to sweep the metal surfaces clean.

As the suspended carbon accumulates, a portion of the liquid contents of boiler is withdrawn at intervals, for instance every thirty minutes, through the residuum outlet 25 to the filter 30 where it is passed through fullers' earth, spent bone-char, or product of similar nature and thereby made free from carbon. The distillate is drawn off the bottom and returned by the pump 11 through the pipe line 12 into the boiler 13, together with such fresh distillate from the tank 10 as may be necessary to take the place of the gas oil freed into the lighter hydrocarbons.

The filters 30 may be of any convenient size and number, and are provided with suitable stop cocks 31 so that those not being charged may be in process of preparation when those in use become clogged with carbon and are no longer efficient. The filtering process being thus intermittent renders the process as a whole continuous.

The vapors leaving the vapor line 21 are condensed in the coil 32 of the condenser 22, and fall as liquid condensate into a condensing tank 33. The same pressure is maintained in the condensing tank as throughout the remainder of the system. Any excess of pressure above 150 pounds on the system is relieved by the relief valve 34. When the condensing tank is nearly full, its contents may be withdrawn through the valve 35 and mixed immediately with low gravity naphtha, thus fixing the lighter hydrocarbons which hitherto have been allowed to escape in apparatus wherein the condensate receiving tank has been kept at atmospheric pressure.

This invention is not restricted to the precise temperatures, pressures and times set forth above, nor to the apparatus shown and described.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent is:

1. The process of producing crude gasolene continuously which consists in distilling in a closed system of circulating channels the liquid portions of the paraffin series having a boiling point of 500° F. or above and known familiarly as gas oil or fuel oil at a pressure from about 125 to 150 pounds and at a temperature ranging from about 600° to 700° F. while maintaining rapid circulation throughout the system, and removing suspended carbon in the charge by intermittent filtration of portions of the charge, whereby filtered oil together with fresh oil may be added to the charge without clogging the system.

2. The process of producing crude gasolene continuously by destructive distillation in a still or closed system subjected to heat throughout which comprises effecting rapid circulation of the contents of the system in a cyclic path by a mechanical agitating device to prevent deposit of carbon therein, and collecting carbon in suspension in said contents and removing said carbon from the still.

3. The process of producing gasolene continuously by destructive distillation in a closed apparatus forming a cyclic system

and having heating surfaces inclined underneath, which comprises preventing the deposition of carbon on said surfaces by mechanically circulating the charge over said surfaces toward their lower ends, providing portions of the apparatus where the carbon particles can collect, periodically removing said carbon particles by intermittent filtration, and returning the filtrate to the system for further treatment.

4. The process of producing crude gasolene continuously by cracking in a closed system of tubes and receptacles arranged for positive circulation of the charge therein, which comprises condensing the lighter hydrocarbons as given off, and preventing clogging of the still by removing from time to time portions of the charge from the lowest point of action, filtering said portions in a suitable filter, and returning the carbon free filtrate to the system together with as much additional fresh distillate as may be necessary to take the place of the distillate converted into lighter hydrocarbons.

Signed at Vinita, Okl., this 24th day of April, 1915.

ARTHUR D. SMITH.

3230

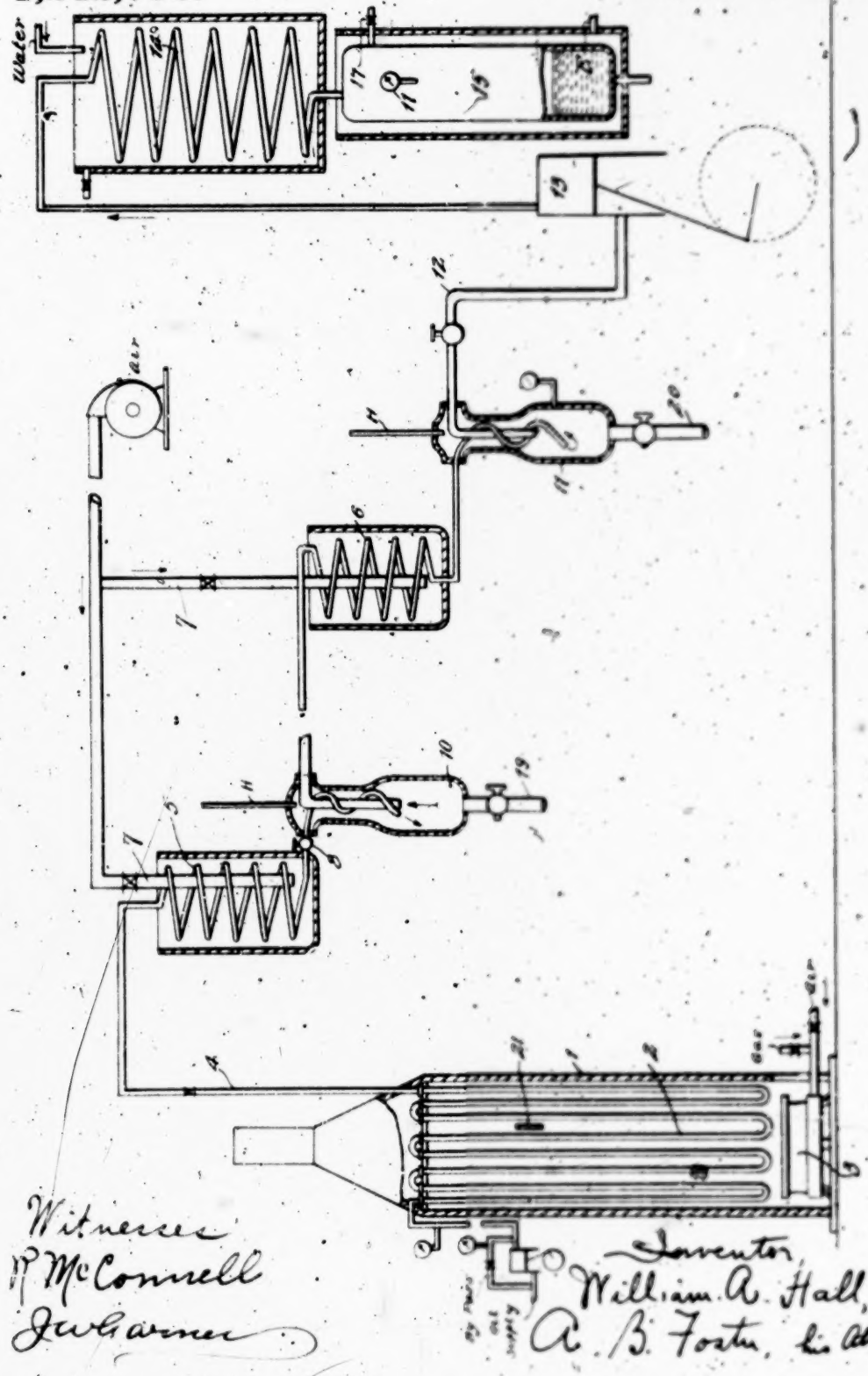
W. A. HALL.

PRODUCING MOTOR FUEL.

APPLICATION FILED APR. 4 1914.

1,242,796.

Patented Oct. 9, 1917.



Witnesses
W. McConnell
J. W. Garner

Inventor
William A. Hall, by
A. B. Foster, his Atty.

UNITED STATES PATENT OFFICE.

WILLIAM AUGUSTUS HALL, OF NEW YORK, N. Y.

PRODUCING MOTOR-FUEL.

1,242,796. Specification of Letters Patent. Patented Oct. 9, 1917.

Application filed April 4, 1914. Serial No. 829,634.

To all whom it may concern:

Be it known that I, WILLIAM AUGUSTUS HALL, a citizen of the United States of America, and resident of New York, United States of America, have invented a certain new and useful Improvement in Processes of Producing Motor-Fuel, of which the following is a specification.

This invention relates to an improved process for the production from heavy hydrocarbons of liquid fuels in the form of motor spirit suitable for use in the usual carbureters of internal combustion engines and to the apparatus employed in said process.

I take any cheap hydrocarbon, for instance, a distillate such as a gas oil of 40 to 44° Be., and a boiling point of about 110° C.

I subject this hydrocarbon to a temperature of about 650° C., under a pressure of about 70 pounds per square inch in a suitable coil of pipe, whereby the oil is cracked and a considerable portion gasified. From this coil of pipe which I term the "converter" the mixture of oil vapor and gas thus produced is passed through suitable coolers whereby the temperature of the mixture is lowered to about 200° C. and the mixture thus cooled is fractionally condensed in a suitable separator or separators, preferably with a material reduction of pressure. The amount of pressure maintained in the separator or separators may vary considerably, a pressure of 20 or 25 pounds per square inch (above atmospheric) being suitable. The object of this step is to remove from the gases and vapors, the major portion of those fractions, of which the boiling points are too high for use in the production of a motor fuel, for the purpose specified. The major portion of those fractions of the mixture which are non-volatile at about 200° C., are thus separated in a liquid state, from the remaining gases and vapors, which gases and vapors, are then recompressed, at a temperature of approximately 200° C., to a pressure of about 70 pounds per square inch, by means of any suitable mechanical compressor, and then condensed under pressure in the cooler.

I have found that if the gases and vapors produced by cracking heavy hydrocarbons under the conditions above indicated and from which those fractions condensable at about 200° C. have here been separated by fractional condensation, are maintained in contact with one another at a temperature say about 200° C., and under a pressure of about 70 pounds per square inch or more and are then cooled together not only are the vapors of the liquid hydrocarbons condensed but that a considerable quantity of the easily liquefiable gaseous hydrocarbons are also condensed and that from the final condensed liquid these condensed gases (whatever may be the reason whether chemical or otherwise) do not escape at ordinary temperatures.

Apparatus suitable for the performance of the improved process is illustrated diagrammatically in the figure of the accompanying drawing.

Referring to said drawings, 1 depotes a cracking apparatus, or converter, containing a coil of pipe 2, in which the hydrocarbon oil is subjected to a temperature of about 650° C., and under a pressure of 70 pounds per square inch, more or less. This temperature is measured by a pyrometer 21, placed between the coils of pipe 2, as shown.

The heat is supplied by means of a burner 3, by which operation the oil is cracked and a considerable proportion thereof is gasified. From this converter a connection 4 leads to cooling coils 5 and 6, which may be cooled by air or by other suitable cooling fluid blown in through the tubes 7 and serving as coolers whereby the temperature of the mixture of oil vapor and gas is lowered to about 200° C. The mixture of gases and vapors, thus cooled, and also preferably reduced in pressure, and by suitably disposed valves, including the valve 8, in the piping, is then fractionally condensed and separated in suitable separators 10 and 11, whereby those portions of the mixture, liquid at about 200° C., are extracted from the vapors and gases, in the form of a liquid. This liquid may be drawn off through the pipes 19 and 20, provided with suitable valves and with suitable cooling means as illustrated. The gas and vapors pass by pipes 12 to a compressor 13 and are then forced through the pipe 14, which is surrounded by a cooling fluid, such as water, thence into the receptacle 15, which is likewise water-jacketed, and in the parts 14 and 15, a pressure for example 70

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pounds per square inch or more is maintained by means of the compressor 13. Upon the amount of pressure employed in this step, will depend, to a certain extent, the properties of the product.

In the preferred form of execution of the process, I lower the pressure considerably, so that during the first cooling operation, in the coolers 5 and 6, and in the traps 10 and 11, a pressure materially below that employed in the cracking operation prevails, that is to say, the cracking operation is effected at a pressure of, say about 70 lbs. per square inch. The pressure is then released and the gases and vapors cooled to about 200° C., (or say to about 160 or 200° C.), while at a low pressure, which may be atmospheric or slightly more, under which conditions the solid carbon, tarry matters, any uncracked oil present, and substantially all products not volatile at the temperature of the cooling are condensed and separated, after which the pressure is again raised to 70 lbs. per square inch, or more, before the final cooling and condensation.

This drop in pressure in the preliminary condensation is of especial value in the process, and constitutes a material improvement over the modification of the process in which the pressure is held up to (or near) the pressure of the cracking coil. By this lowering of pressure, the operation of removing the tarry matters and especially the solid matter (free carbon, etc.) is greatly accelerated, and moreover the entire apparatus is very much simplified, and the maintenance of a uniform temperature at the outlet of the trap 11, and a uniform composition of this material, is made much easier.

By thus lowering the pressure and cooling to the desired temperature, substantially all of the free carbon and very difficultly volatile material separates in the first trap 10, and the material which separates in the second cooler and trap is free from solid carbon and free from coke-like material, and this second condensate (termed "light residue") can be directly employed for making a second "run" through the apparatus, without filtration or other preliminary treatment.

Another reason why I prefer to lower the pressure during the preliminary condensation is the following: It is well known that the boiling point of a given liquid (and likewise the temperature at which the vapor of such liquid condenses to the liquid state) is dependent upon the existing pressure. Lowering the pressure lowers the boiling point. Moreover, by lowering the pressure during the condensation operation, it is possible to secure a much more accurate condensation, while removing the undesirable fractions, and while leaving in some of the desirable constituents which would be removed if the preliminary condensation were effected at or near the converter pressure.

A pipe 17 serves to lead from the upper end of the condenser the non-condensable portion of the gases.

The cracking of oil under pressure by heat lower than indicated and the separation during distillation of the heavier fractions by fractional condensation are not in themselves new but it is the combination of these processes so carried out as to produce both vapors and gases together with the subsequent condensation under pressure of the mixed vapors of liquid hydrocarbons and the easily liquefiable gaseous hydrocarbons which constitutes the essence of my invention.

The modification of the process in which the pressure of the gases and vapors is not lowered in the preliminary cooling step (separation of tarry matters) is included in the claims of my copending application Serial No. 824,194, filed Mar. 12, 1914.

What I claim is:—

1. A process of making a motor fuel which comprises cracking hydrocarbon oils at a temperature of about 600 to 650° C., under a pressure of about 70 pounds per square inch, thereafter cooling the resulting gases and vapors to about 200° C., while said gases and vapors are at a lower pressure to separate the most readily condensable portions therefrom, increasing the pressure of the remaining gases and vapors, to a pressure of at least about 70 pounds per square inch, and thereafter cooling the mixture of gases and vapors to condense the product.

2. A process of making a motor fuel from an oil of high boiling points, which comprises cracking said oil under a pressure exceeding four atmospheres, at a temperature of not less than about 600° C., thereby producing a mixture comprising gases and vapors of both high and low boiling points, thereafter lowering both the temperature and pressure sufficiently to remove the fractions of higher boiling points, thereafter increasing the pressure to over four atmospheres and then further lowering the temperature sufficiently to condense the product.

3. A process of producing a motor fuel from oil distillates having boiling points higher than gasolene, said process comprising, first, cracking said oil, under a pressure of about 70 pounds per square inch, and at a temperature materially above 500° C., second, lowering the temperature of the gases and vapors to about 200° C., while allowing the pressure to drop somewhat; third, compressing the gases and vapors to a pressure of at least 70 pounds per square inch, and fourth, cooling the same under said pressure, to condense the motor fuel.

4. A process of producing a motor fuel which comprises cracking a hydrocarbon oil under a pressure materially above atmospheric at a temperature sufficient to form gases, and vapors of materials having high boiling points, and unsaturated hydrocarbon vapors, then cooling the gases and vapors, at a pressure materially lower than that used in the cracking operation, to a temperature of above 100° C., but not above about 200° C., to remove materials having higher boiling points, thereafter subjecting the remaining gases and vapors, at a temperature of 100 to 200° C., to a pressure of not less than about 70 pounds per square inch, and thereafter cooling the gases and vapors to condense the motor fuel.

5. A process of producing a motor fuel which comprises cracking a hydrocarbon oil under a pressure materially above atmospheric at a temperature sufficiently high to convert a portion of the oil into fixed gases, and to produce vapors containing considerable percentages of unsaturated hydrocarbons, cooling the vapors and gases, while under a pressure materially below that employed in the cracking operation, sufficiently to separate the portions having boiling points above about 200° C., thereafter subjecting the remaining gases and vapors, at a temperature of 100 to 200° C., to a pressure materially above that used in the said cooling step, and then cooling the gases and vapors sufficiently to cause condensation of the motor fuel.

6. A process of making a motor fuel, which comprises cracking a mineral oil under high pressure, at a temperature above 500° C., cooling the gases and vapors, while at a pressure materially below that used in the cracking operation, to a temperature of not over about 200° C., to separate out materials having high boiling points, further compressing the gases and vapors remaining from said cooling step, and cooling the gases and vapors while in said compressed state, to condense out the motor fuel.

7. A process of making a motor fuel which comprises cracking hydrocarbon oils at a temperature above 500° C., under a pressure of about 70 pounds per square inch, lowering the pressure of the resulting gases and vapors, down to a pressure not greatly exceeding atmospheric, cooling the gases and vapors to a temperature below 200° C., but not materially below 100° C., to separate the most readily condensable portions therefrom, recompressing the gases to a pressure of at least 70 pounds per square inch, and cooling the remaining gases and vapors, under said pressure.

8. A process of producing a motor fuel which comprises passing a current of hydrocarbon oil at a pressure of about 70 pounds per square inch through a pressure-resisting tortuous pipe, located in a furnace heated to approximately 600° C.; reducing the pressure of the gases and vapors, while cooling the same to a temperature of about 200° C., and removing the condensed materials; recompressing the gases and vapors while materially above ordinary atmospheric temperature, to a pressure of approximately 70 pounds per square inch, and thereafter cooling the gases and vapors to condense the motor-fuel.

9. A process of producing, from mineral oil, a liquid fuel suitable for use in internal combustion engines, consisting in cracking the oil under a pressure materially above atmospheric to produce gases and vapors, expanding such gases and vapors, and cooling the same to a temperature sufficiently low to condense out material not sufficiently volatile for use as motor fuel, removing such condensed material and thereafter subjecting the remaining gases and vapors, to an increase in pressure, while the gases are in a heated state, and condensing the product so formed.

10. A process of producing a motor fuel which comprises cracking oil under a pressure of several atmospheres at a high temperature to produce gases and vapors, releasing the pressure of the gases and vapors produced within a short time after their production, cooling said gases and vapors to separate such material as is not readily volatile, mechanically compressing the partially cooled, but still warm vapors and gases from which the fractions of high boiling points have been separated, cooling and condensing the products resulting from said compression, while under a pressure of several atmospheres.

11. A process of producing a liquid motor fuel, which comprises cracking an oil at a high temperature under a pressure, materially above atmospheric, to produce gases and vapors, releasing the pressure of the gases and vapors shortly after their production, passing the gases and vapors through a dephlegmator to remove materials of relatively high boiling points from those of relatively low boiling points, mechanically compressing the vapors and gases remaining, and further cooling and condensing the products.

12. A process of producing a motor fuel which comprises (*a*) passing hydrocarbon oil containing fractions having higher boiling points than ordinary gasolene, in the form of a flowing current through a tubular retort under a pressure of approximately 70 pounds per square inch maintained at a temperature of about 650° C., whereby the oil is cracked and a considerable portion is gasified, (*b*) thereafter lowering the pressure to approximately atmospheric, lowering the temperature to approximately 200

C., in order to condense and separate at least a portion of the products of high boiling points, (*c*) recompressing the gases and vapors to a pressure of approximately 70 pounds per square inch, while at a temperature of approximately 200° C., and thereafter (*d*) cooling the remaining gases and vapors together, to condense out the motor fuel.

13. A process of making a motor fuel which comprises cracking a flowing current of hydrocarbon oil at a temperature of about 600 to 650° C., under a pressure of about 70 pounds per square inch, thereafter cooling the resulting gases and vapors to about 200° C., while said gases and vapors are at a lower pressure than that used in the cracking operation, to separate at least a portion of the most readily condensable fractions, increasing the pressure of the remaining gases and vapors, while still at a temperature above normal atmospheric temperature, to a pressure of at least about 70 pounds per square inch, and thereafter cooling the mixture of gases and vapors to condense the product.

14. A process of producing a motor fuel which comprises heating a flowing current of hydrocarbon oil containing fractions having higher boiling points than ordinary gasolene, under pressure materially above atmospheric, to a temperature capable of cracking the said oil with the production of permanent gases, lowering both the pressure and temperature of the gases and vapors thereby produced, sufficiently to separate out fractions having boiling points too high for use in the production of a gasolene substitute, recompressing the remaining mixture of gases and vapors, while at a temperature materially above atmospheric, and thereafter cooling the remaining gases and vapors under superatmospheric pressure, to condense out the motor fuel.

15. A process of making a motor fuel from an oil of high boiling points which comprises cracking a flowing current of said oil under a pressure exceeding four atmospheres, at a temperature of not less than about 600° C., thereby producing a mixture comprising gases and vapors of both high and low boiling points, thereafter lowering both the temperature and pressure sufficiently to remove at least a portion of the fractions of high boiling points, thereafter increasing the pressure in the remaining gases and vapors, while the temperature of the same is above normal atmospheric temperature, and thereafter further lowering the temperature sufficiently to condense the product.

16. A process of producing a motor fuel which comprises cracking a hydrocarbon oil under pressure materially above atmospheric, at a temperature of about 500 to 650° C., to form permanent gases and vapors of materials having high boiling points, and unsaturated hydrocarbon vapors, thereafter cooling such gases and vapors while at a pressure materially lower than that employed in the cracking operation, to a temperature of not above approximately 200° C., to remove materials having high boiling points, thereafter subjecting the remaining gases and vapors, while at a temperature of 100 to 200° C., to a pressure of not less than about 70 pounds per square inch, and thereafter cooling the gases and vapors to condense the motor fuel.

17. A process of producing a motor fuel suitable for use in carbureters of internal combustion engines, from oil distillates having boiling points higher than ordinary gasolene, said process comprising first cracking said oil under a pressure of about 70 pounds per square inch, in the form of a flowing current, at a temperature materially above 500° C., second lowering the temperature of the gases and vapors to about 200° C., while allowing the pressure to drop somewhat, third recompressing the gases and vapors to a pressure of at least 70 pounds per square inch while said gases and vapors are at a temperature materially above ordinary atmospheric temperature, and fourth, cooling the remaining gases and vapors under said pressure, to condense the motor fuel.

18. A process of producing a motor fuel which comprises cracking a hydrocarbon oil under a pressure materially above atmospheric, at a temperature of about 500 to 650° C., to convert a portion of the oil into fixed gases, and to produce vapors containing considerable percentages of unsaturated hydrocarbons, cooling the vapors and gases, while under a pressure materially below that employed in the cracking operation, sufficiently to separate the portions having boiling points above about 200° C., thereafter subjecting the remaining warm gases and vapors, to a pressure materially above that used in the said cooling step, and then cooling the gases and vapors sufficiently to cause condensation of the motor fuel.

19. A process of making a motor fuel which comprises cracking hydrocarbon oils at a temperature of 600 to 650° C., under a pressure of about 70 pounds per square inch, lowering the pressure of the resulting gases and vapors, down to a pressure not greatly exceeding atmospheric cooling the gases and vapors to a temperature below 200° C., to separate the most readily condensable portions therefrom, recompressing the gases to a pressure of at least 70 pounds per square inch, and cooling the remaining gases and vapors, under said pressure.

20. A process of producing a motor fuel which comprises cracking a hydrocarbon oil

under a pressure materially above atmospheric to produce gas and vapor; cooling the gas and vapor while at a pressure materially below that used in the cracking operation, sufficiently to separate the materials of high boiling points; thereafter subjecting the resulting gases and vapors while at a temperature above atmospheric, to a pressure materially greater than that used in said first cooling operation, and thereafter further cooling the gases and vapors, under a pressure of several atmospheres.

21. A process of producing a motor fuel, which comprises cracking a hydrocarbon oil under pressure materially above atmospheric, to produce gas and vapor, cooling the gas and vapor while at a pressure materially below that used in the cracking operation, sufficiently to separate the materials of high boiling points; thereafter subjecting the resulting gases and vapors while at a temperature above ordinary atmospheric temperature, to a pressure of not less than 70 pounds per square inch, and thereafter cooling the gases and vapors under a pressure of several atmospheres.

22. A process of making a motor fuel, which comprises cracking a mineral oil under high pressure, at a temperature above 500° C., cooling the gases and vapors, while at a pressure materially below that used in the cracking operation, to a temperature of not over about 200° C., to separate out materials having high boiling points, further compressing the gases and vapors remaining from said cooling step while still in a heated condition, and cooling the gases and vapors while in said compressed state, to condense out the motor fuel.

23. A process of producing a motor fuel from hydrocarbon oil consisting in cracking said oil under superatmospheric pressure at a temperature upward of 600° C., thereby forming gases and vapor, reducing the pressure of the gases and vapor and separating by fractional condensation that portion of the liquid which is non-volatile at a temperature of approximately 200° C., recompressing the remaining hot gases and vapors, and condensing them together under pressure to produce a liquid substantially as described.

24. A process of producing a motor fuel which comprises passing a current of hydrocarbon oil at a pressure of about 70 pounds per square inch through a pressure-resisting tortuous pipe, located in a furnace heated to approximately 600° C., reducing the pressure of the gases and vapors, while cooling the same to a temperature of about 200° C., and removing the condensed materials; recompressing the gases and vapors while at said temperature, to a pressure of approximately 70 pounds per square inch, and thereafter cooling the gases and vapors to condense the motor fuel.

In testimony whereof I have signed my name to this specification in the presence of two subscribing witnesses.

WILLIAM AUGUSTUS HALL.

Witnesses:
H. D. JAMESON,
O. J. WORTH.

3238

C. G. LAMBERT.

APPARATUS FOR CRACKING OILS.

APPLICATION FILED JULY 7, 1917.

1,245,930.

Patented Nov. 6, 1917.

3 SHEETS—SHEET 1.

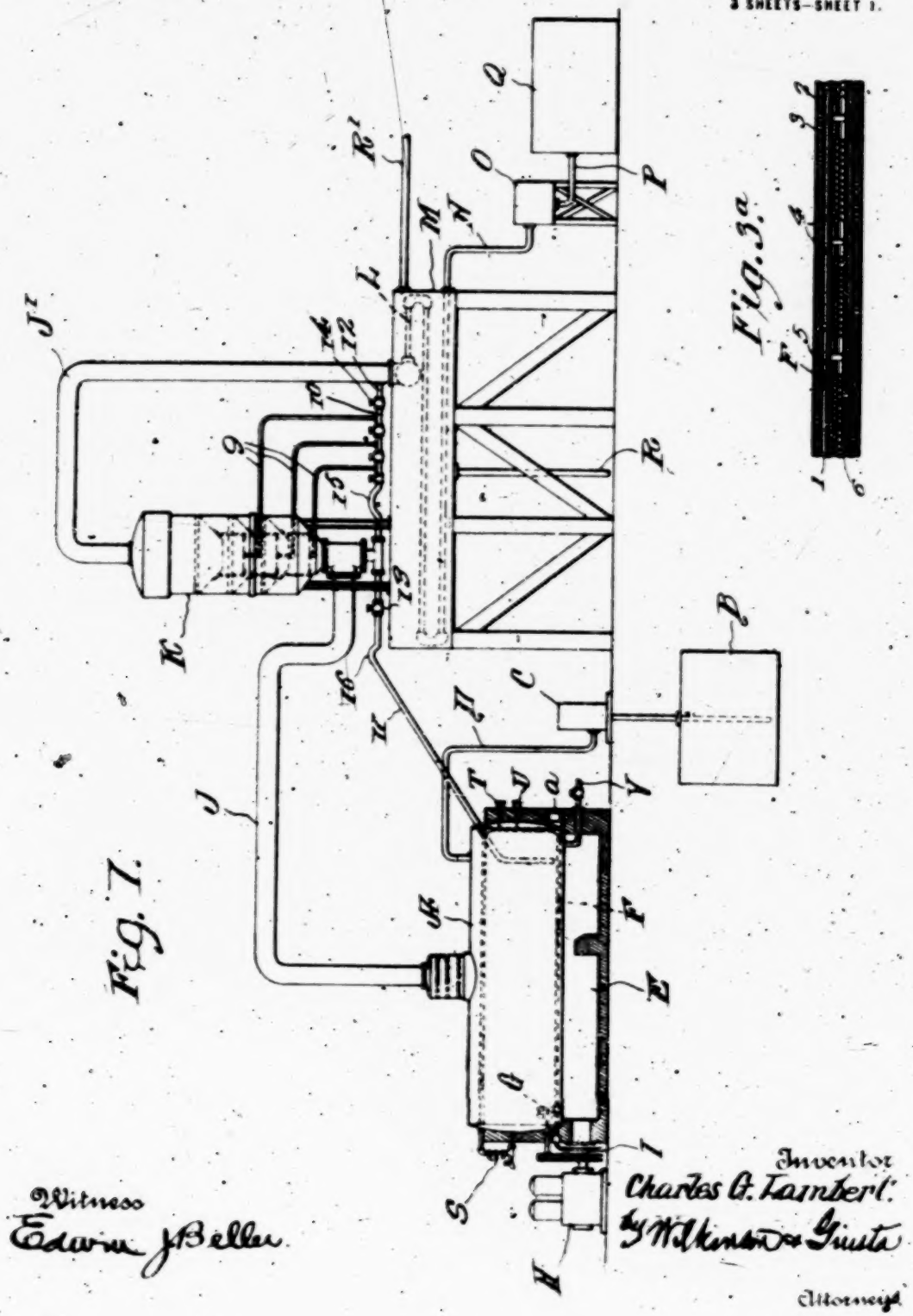

Fig. 1.

Fig. 3a.

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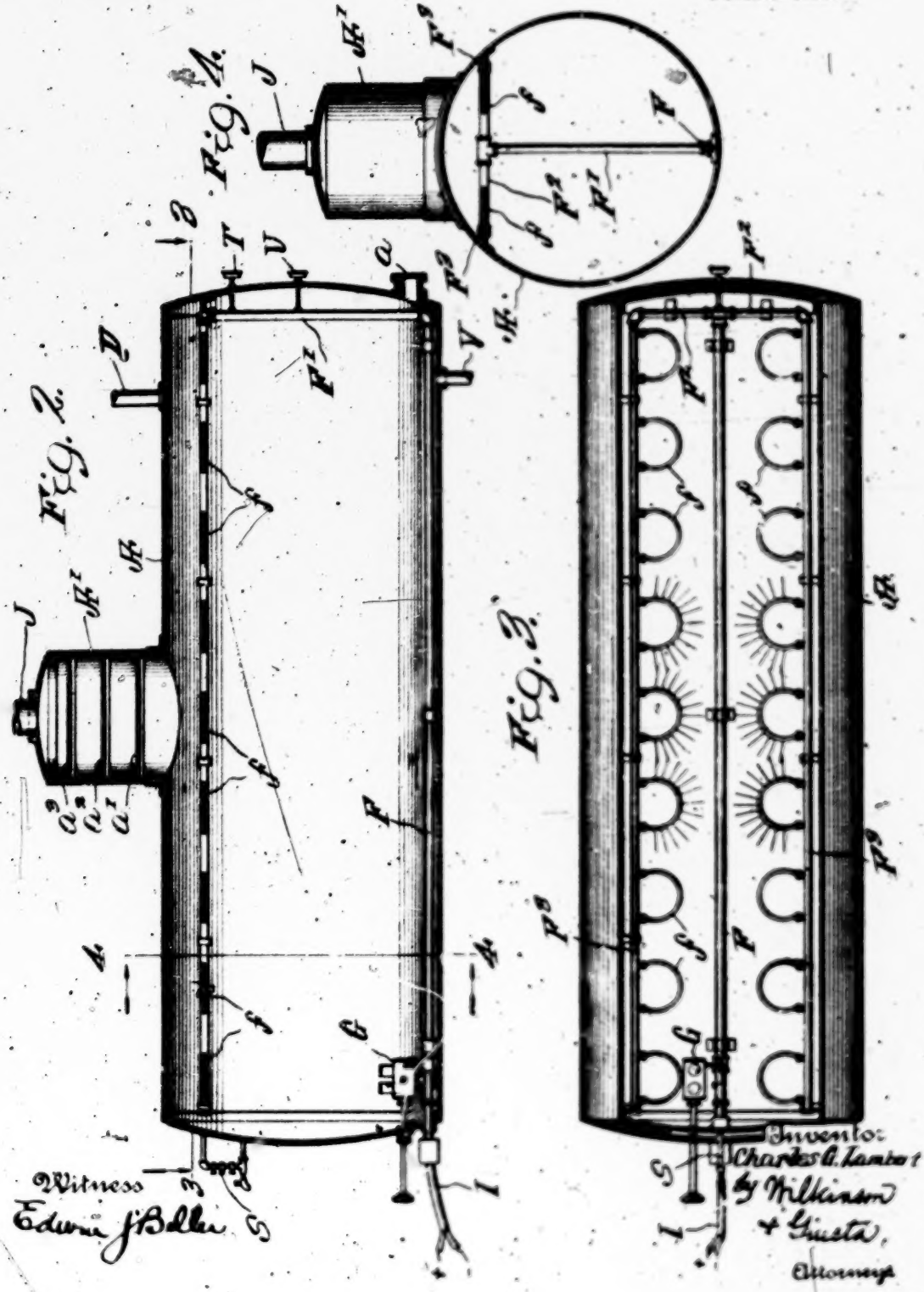
APPARATUS FOR CRACKING OILS.

APPLICATION FILED JULY 7, 1917.

1,245,930.

Patented Nov. 6, 1917.

3 SHEETS—SHEET 2.



3242

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APPLICATION FILED JULY 7, 1917.

1,245,930.

Patented Nov. 6, 1917.

3 SHEETS—SHEET 3.

Fig. 5.

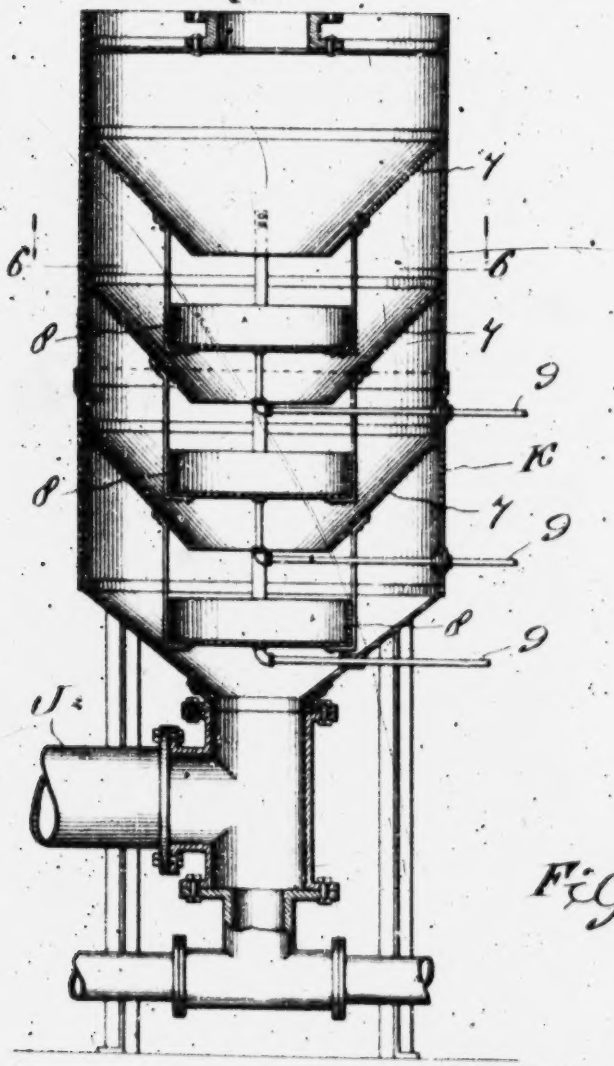


Fig. 8.

Fig. 9.

Fig. 10.

Fig. 4.

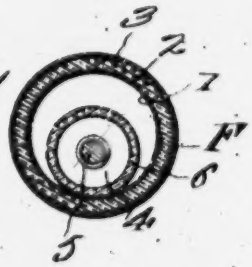
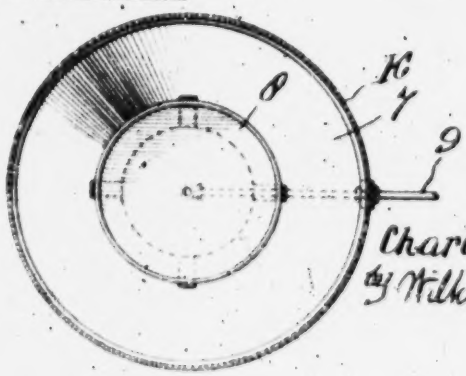


Fig. 6.



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UNITED STATES PATENT OFFICE.

CHARLES GUY LAMBERT, OF SHREVEPORT, LOUISIANA.

APPARATUS FOR CRACKING OILS.

1,245,930. Specification of Letters Patent. Patented Nov. 6, 1917.

Application filed July 7, 1917. Serial No. 179,214.

To all whom it may concern:

Be it known that I, CHARLES GUY LAMBERT, a citizen of the United States, residing at Shreveport, in the parish of Caddo and State of Louisiana, have invented certain new and useful Improvements in Apparatus for Cracking Oils; and I do hereby declare the following to be a full, clear, and exact description of the invention, such as will enable others skilled in the art to which it appertains to make and use the same.

My invention relates to processes for cracking oil, and it relates especially to that method of cracking oil which consists in heating the oil to a high temperature and under high pressure and then allowing it to escape and expand; whereby the lighter particles are caused to separate from the heavier and rise, and are carried away to be separated and clarified and refined, as will be hereinafter more fully described.

My invention will be understood by reference to the accompanying drawings, which show an embodiment of the preferred form, and in which like parts are indicated by like reference symbols throughout the several views:

Figure 1 is a diagram showing a side elevation of the complete apparatus, the furnace being shown in section;

Fig 2 shows a central longitudinal section through the cylindrical still shown in Fig. 1;

Fig. 3 shows a horizontal section through the upper part of the still, the section being along the line 3—3 of Fig. 2, and looking down;

Fig. 3^a shows a horizontal section through the heating main, and shows the heaters in plan;

Fig. 4 shows a section along the line 4—4 of Fig. 2, and looking in the direction of the arrows;

Fig. 5 shows a section through the separator shown in Fig. 1, the parts being on a larger scale than in said figure;

Fig. 6 shows a section along the line 6—6 of Fig. 5, and looking down;

Fig. 7 shows a cross section through the heating main containing the electric heater, and through which the oil continuously passes to the sprays;

Figs. 8 and 9 show respectively, a central section, and an end view of a nozzle which may be substituted for the spraying device shown in Fig. 3; and

Fig. 10 shows still another modified form of nozzle in which the spray issues through an elongated slit instead of through a circular opening.

Referring first to Figs. 1 to 4, A represents a cylindrical still into which the oil is pumped from the reservoir B by the pump C through the pipe D. This still is provided with a suitable manhole and cover *a*.

Beneath the still is provided a suitable furnace E. Mounted in the still is a heating main F into which the oil is pumped from the pump G driven in any convenient way, as by the engine H. This pump draws oil from the interior of the still and forces it into the main F. This main, shown in Fig. 7, is preferably composed of a strong pipe 1 surrounded by suitable heat insulating material 2, and is covered by a protective coating 3.

Mounted inside of this main is a series of electric heating coils 4 surrounding the core 5, and covered by non-conducting material 6 so that the electric current supplied to the heaters is insulated from the main.

Electric current is supplied by conductors I connected to any suitable source of low tension currents of electricity.

The heating main F is connected by the vertical pipe F′ to the branch pipes F^2, which are connected, respectively, to the delivery pipes F^3, the oil escaping from these pipes in the form of a series of sprays.

These sprays may be secured by using U-shaped pipes *f* provided with minute perforations therethrough as shown in Figs. 2 and 3; or, instead of these U-shaped pipes *f*, suitable nozzles *f′*, as shown in Figs. 8 and 9, or nozzles f^2, as shown in Fig. 10, may be provided.

On top of the still the dome A′ is mounted, which is provided with a series of perforated baffle plates a', a^2, a^3, the perforations in the plate a' being preferably of larger diameter than those in the plate a^2, and the perforations in the plate a^2 being of preferably larger diameter than those in the plate a^3. The number of these baffle plates may be increased or decreased as desired.

This dome is connected by the vapor line J to the base of the separator K, which is provided with inverted truncated cones 7, beneath each of which are suspended drip pans 8 which catch the condensates of the gases, while the gaseous particles rise upward and are carried off by the pipe J′ con-

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stituting the second part of the vapor line, which delivers the gas to any suitable condensing coils L in the condenser M, the condensed oil being drained off by the pipe N to the weighing box O, and thence passing through the pipe P to the receiving tank Q.

Each of the drip pans 8 is provided with a drain pipe 9 connected to the manifold 10, which delivers the liquid caught in the drip pan either to the still by the pipe 11 or to the condenser by the pipe 12; these two pipes 11 and 12 being controlled by suitable valves 13 and 14.

Gooseneck traps 15 and 16 are also preferably provided to prevent the gas from going directly through the pipe J to the manifold 10.

The condenser M is provided with a water supply pipe R and an overflow pipe R'.

The height of the oil in the still is determined by a series of pet cocks S; the temperature of the oil in the main is determined by any suitable pyrometer; and the pressure by any suitable pressure gage, as shown in Figs. 1 and 3.

The operation of the apparatus is as follows:

The oil being pumped into the still to the desired height, a fire is started in the furnace E until the required temperature is reached. The temperature of the oil in the body of the still is brought up to preferably somewhere in the neighborhood of 200° F. This will tend to separate the oil from the water, and the water may be drawn off through a suitable drain V.

The heating of the oil also saves electricity, since the oil is hot when it is forced into the main F.

The oil being heated to the desired temperature, the pump G is started and the electric current is applied. The oil is heated to the desired temperature as it passes through the main F, and I have found in practice that satisfactory results are obtained by heating the oil in the main to a temperature of about 900° F., but the temperature of the oil may be varied within wide limits without departing from the spirit of my invention. Different oils would require different temperatures for treatment.

After the oil is heated to the desired temperature in the main, it escapes through the perforations *f* or the nozzles already referred to. These perforations should be made so small compared to the power of the pump, that the pressure exerted by the pump in the main may be carried as high as several thousand pounds, preferably as high as 5000 pounds per square inch.

The oil escaping through these minute orifices, and under very high pressure and at a high temperature, into the vapor space where the pressure is only slightly higher than that of the atmosphere, will crack the lighter volatile products being given off, and the heavier liquid particles as vapor dropping down into the main body of oil in the still, and the lighter gases, with more or less liquid entrained, will rise upward through the baffle plates in the dome and enter the vapor line where the gases are separated from the liquid particles in the separator K, and the oil is finally condensed in the condenser M and carried to the receiving tank Q.

Access to the interior of the still may be had through the manhole *a*, the contents of the still being of course first drawn off. The sprays, whether in the form of loops or nozzles, or any other form, should preferably be so attached that they may readily be removed from time to time for the substitution of fresh parts, since the holes through the same will tend to wear and become too large, due to the friction of the liquid passing therethrough under the high pressure and at the high temperature.

By having the heating main F inside of the shell of the still, if the pipe 1 should crack or burst under the high pressure to which the oil therein is subjected, or if any of its joints should leak, the oil contained in said pipe would join that already in the still and no harm would be done; whereas if the heating main were outside of the still, any rupture of the pipe 1, or any leakage from its joints, would result in the escape of oil with consequent danger of fire.

I have shown the pump G as inclosed in the shell of the still, and submerged in the body of oil contained therein. This construction is preferred because such high pressure pumps are liable to break down: and if the pump were mounted outside of the still and broke down, there would ordinarily be an escape of oil with corresponding danger of fire, whereas if the pump be inclosed in the still and breaks down, the fall of pressure in the pressure gage would indicate that the pump was not working, and the charge of oil may be distilled by heating it up in the still by means of the fire in the furnace.

After the run has been completed the manhole *a* may be opened and the pump repaired or removed.

While I have shown two delivery pipes F^3 provided with spray openings, one at each side of the still, obviously a single delivery pipe or more than two such pipes may be used if desired.

I do not mean to confine my invention to the cylindrical form of shell for the still A, as various other well known forms may be adopted, if desired.

While I have shown in the apparatus the preferred embodiment of the invention, it will be obvious that different styles of condenser and separator might be used, and that numerous other variations might be

made in the apparatus and the operation of the same without departing from the spirit of my invention.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. Apparatus for cracking oil comprising a still, a heating main in the form of a heavy pipe mounted in said still and coated with heat insulating material, an electric heater mounted in said pipe and electrically insulated therefrom, means for forcing the oil contained in said still under heavy pressure through said heating main, means for spraying the oil delivered by said main into the vapor space in said still, and means for carrying off the gaseous products obtained from said sprays from the top of the still, substantially as described.

2. Apparatus for cracking oil comprising a still, a heating main in the form of a heavy pipe mounted in said still and coated with heat insulating material, an electric heater mounted in said pipe and electrically insulated therefrom, means for forcing the oil contained in said still under heavy pressure through said oil main, means for spraying the oil delivered by said oil main into the vapor space in said still, and means for carrying off the gaseous products obtained from said sprays from the top of the still, with means for separating the condensates from said gaseous products and returning the same to the still, and means for condensing the final gaseous products into the liquid form, substantially as described.

3. Apparatus for cracking oil comprising a still, a heating main in the form of a heavy pipe mounted in said still and coated with heat insulating material, an electric heater mounted in said pipe and electrically insulated therefrom, a pump also located inside the still, for forcing the oil contained in said still under heavy pressure through said main, means for spraying the oil delivered by said main into the vapor space in said still and means for carrying off the gaseous products obtained from said sprays from the top of the still, substantially as described.

4. Apparatus for cracking oil comprising a still, a heating main in the form of a heavy pipe mounted in said still and coated with heat insulating material, an electric heater mounted in said pipe and electrically insulated therefrom, a pump also located in said still for forcing the oil contained in said still under heavy pressure through said main, means for spraying the oil delivered by said main into the vapor space in said still, and means for carrying off the gaseous products obtained from said sprays from the top of the still, with means for separating the condensates from said gaseous products and returning the same to the still, and means for condensing the final gaseous products into the liquid form, substantially as described.

5. Apparatus for cracking oil comprising a still chamber, a heating main in the form of a heavy pipe mounted in said still chamber and coated with heat insulating material, a series of electric heaters mounted in said pipe and electrically insulated therefrom, means for forcing the oil contained in said still under heavy pressure through said main, branch pipes located in the upper part of the still chamber and connected to said main, a series of spraying devices detachably connected to said branch pipes for spraying the oil delivered by said oil main into the vapor space in the upper part of said still chamber, and means for carrying off the gaseous products obtained from said sprays from the top of the still, substantially as described.

6. Apparatus for cracking oil comprising a still chamber, a heating main in the form of a heavy pipe mounted in said still chamber and coated with heat insulating material, a series of electric heaters mounted in said pipe and electrically insulated therefrom, means for forcing the oil contained in said still under heavy pressure through said main, branch pipes located in the upper part of the still chamber and connected to said main, a series of spraying devices detachably connected to said branch pipes for spraying the oil delivered by said oil main into the vapor space in the upper part of said still chamber, and means for carrying off the gaseous products obtained from said sprays from the top of the still, with means for separating the condensates from said gaseous products and returning the same to the still, and means for condensing the final gaseous products into the liquid form, substantially as described.

7. Apparatus for cracking oil comprising a still chamber, a heating main in the form of a heavy pipe mounted in said still chamber and coated with heat insulating material, a series of electric heaters mounted in said pipe and electrically insulated therefrom, a pump also contained in said still chamber for forcing the oil contained in said still under heavy pressure through said main, branch pipes located in the upper part of the still chamber and connected to said main, a series of spraying devices detachably connected to said branch pipes for spraying the oil delivered by said oil main into the vapor space in the upper part of said still chamber, and means for carrying off the gaseous products obtained from said sprays from the top of the still, substantially as described.

8. Apparatus for cracking oil comprising a still chamber, a heating main in the form of a heavy pipe mounted in said still chamber and coated with heat insulating ma-

terial, a series of electric heaters mounted in said pipe and electrically insulated therefrom, a pump also contained in said still chamber for forcing the oil contained in said still under heavy pressure through said main, branch pipes located in the upper part of the still chamber and connected to said main, a series of spraying devices detachably connected to said branch pipes for spraying the oil delivered by said oil main into the vapor space in the upper part of said still chamber, and means for carrying off the gaseous products obtained from said sprays from the top of the still, with means for separating the condensates from said gaseous products and returning the same to the still, and means for condensing the final gaseous products into the liquid form, substantially as described.

In testimony whereof, I affix my signature.

CHARLES GUY LAMBERT.

3248

C. ELLIS.

TREATING OILS.

APPLICATION FILED APR. 29, 1913.

1,249,278.

Patented Dec. 4, 1917.

Fig. 1.

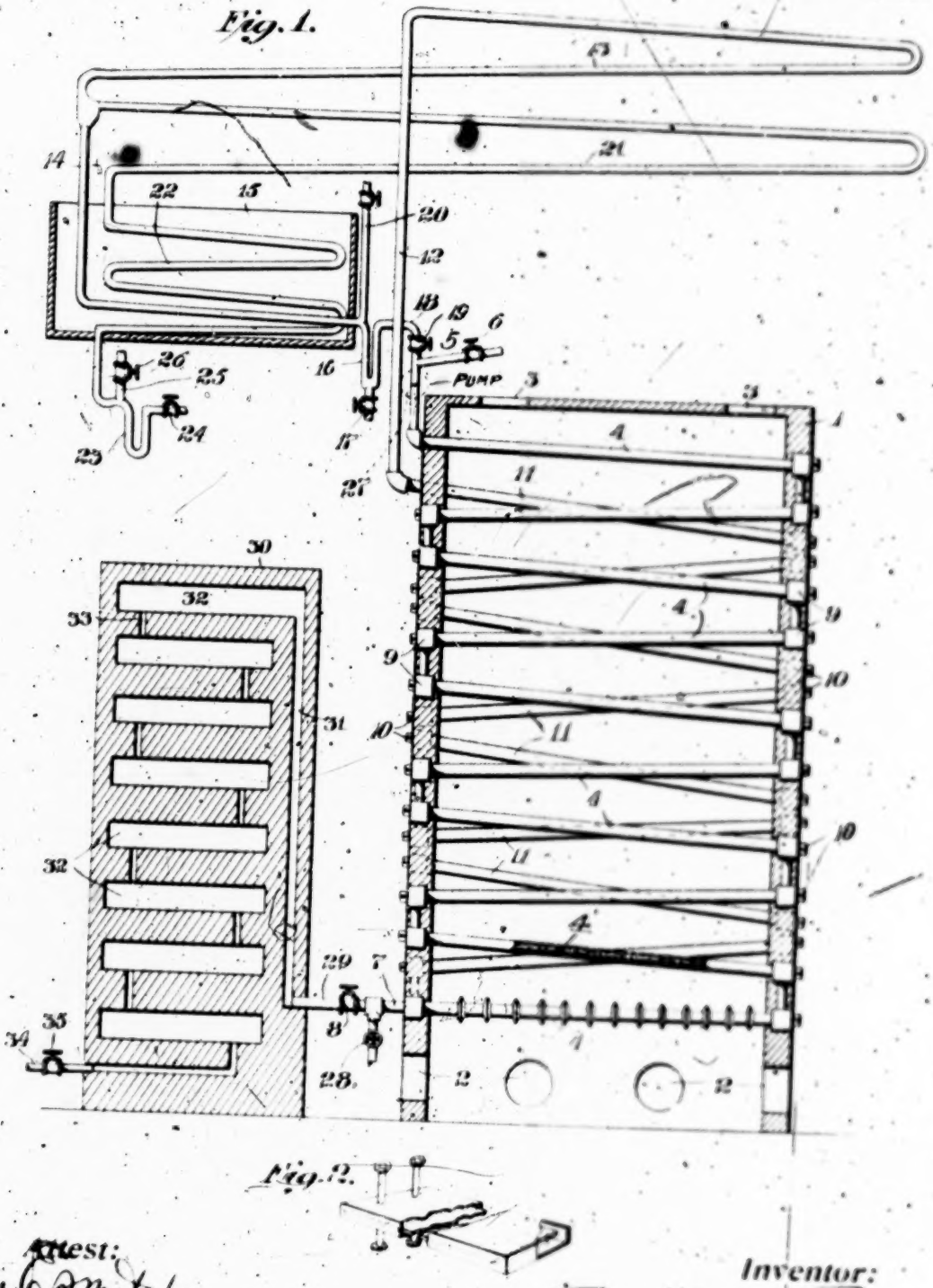

Fig. 2.

Witnesses:

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A. Richardson

Inventor:

Carleton Ellis

UNITED STATES PATENT OFFICE.

CARLETON ELLIS, OF MONTCLAIR, NEW JERSEY, ASSIGNOR TO ELLIS-FOSTER COMPANY, A CORPORATION OF NEW JERSEY.

TREATING OILS.

1,249,278. Specification of Letters Patent. Patented Dec. 4, 1917.

Application filed April 29, 1913. Serial No. 764,223.

To all whom it may concern:

Be it known that I, CARLETON ELLIS, a citizen of the United States, and a resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Treating Oils, of which the following is a specification.

This invention relates to a process of making lighter from heavier oil petroleum products and relates in particular to the production of gasolene from kerosene or other heavier oils by heat decomposition under conditions which enable the production of a substantial or maximum yield of light spirit by virtue of such operation.

Reference is had to the accompanying drawings in illustration of the process and apparatus of the present invention, these drawings representing the preferred embodiment from which various modifications and deviations are feasible as will be evident to those skilled in the art after inspection hereof.

In the drawings Figure 1 shows in diagrammatic fashion a tubular heating system and condensing apparatus which are depicted partly in vertical section and partly in elevation. Fig. 2 shows a form of heating element.

In the drawings 1 is a chamber preferably of considerable height having inlets 2 for the admission of hot gasses or products of combustion or inflammable gas for heating purposes. At the top of the chamber are outlets 3 which, of course, may be if desired connected with a suitable stack. In the chamber 1 are arranged a series of nearly horizontal pipes 4 which, however, as shown preferably have a slight inclination so as to zigzag across the chamber from top to bottom, the lower tube of the series being preferably less inclined than the other tubes. 5 is an inlet pipe for kerosene or other oil used for the present purpose, this pipe being provided with the valve 6. Through this pipe also may be fed water or aqueous solution (a diluted solution of ammonium nitrate may be used) or suitable catalytic material in solution. The pipe 5 as will be noted communicates with the uppermost pipe of the aforesaid series 4. The lowermost pipe of the series 4 has an outlet 7 controlled by the valve 8. The several pipes or tubes are connected by means of the headers 9 in which are placed plugs 10 which enable the tubes to be opened and viewed from end to end, or readily cleaned as occasion requires. The second series of tubes is indicated by 11. These tubes form a rising system leading from the lowermost tube of series 4 and are connected one with another in a manner similar to the series 4. Preferably the series 11 is given a greater inclination than the series 4 and preferably the uppermost tube of series 11 is below the uppermost tube or tubes of series 4. The uppermost tube of series 11 communicates with a riser 12 connected with an air condenser 13, one member of which yields its condensation products to the pipe 14 which passes through a condenser trough 15 filled with water and connects with the trap 16 which is fitted with the draw-off 17. The riser 20 provided with a valve allows of the separation of gas and uncondensable products which may be separately collected. From the trap 16, the pipe 18 equipped with the valve 19, leads to the uppermost pipe of the tubular heating series 4. A pump 27 may be interposed in this pipe to facilitate the removal of the liquid products from pipe 14 and trap 16 especially when the tubular system is operating under pressure. A second wing or member of the air condenser 21 serves for the condensation of lighter products more particularly the gasolenes which pass through the condensing pipe 22 going thence to the trap 23 having the draw-off 24 from which gasolene or similar light products may be withdrawn. 25 is a gas venting pipe having the valve 26. Although the air condensing members 13 and 21 are but two in number as here shown it will be evident that the number may be increased to provide for the separation of several fractions as desired. The size of the air condenser should be proportioned with respect to the output of vapors from the heating chamber 1.

The function of the rising tubular series 11 is mainly that of digestion and final reaction which ordinarily does not require an extremely elevated temperature, but is in substance a time reaction involving rearrangement of molecules to establish substantial or ultimate equilibrium of the components of the resulting gasolene whereby such product is stabilized. It is to be under-

stood that the term "equilibrium" as here employed has reference to the molecular condition of the components of the gasolene resulting from the reactions effected during the digestion of the products of the heat decomposition of the material treated, in which reactions unsaturated or otherwise unstable bodies produced, act by chemical union with the gases, and particularly hydrogen, produced by such decomposition or by union with each other or by polymerization, to produce saturated or otherwise substantially stable compounds whereby the gasolene is stabilized. Such digestive function, as it may perhaps be termed, may obtain in the apparatus 30 and the tubular heating series 11 may be dispensed with, this being done in the appartus shown, by inserting the plug in the lower end of the lower member of the series 11 so far as to prevent the flow of vapors through said series. The pipe 7 has a draw-off 28. An extension 29 of the pipe 7 enters the apparatus 30 and connects with the riser 31 which in turn communicates with the digestion chambers 32. These digestion chambers are preferably of considerable length and width, but of a relatively small height, and connected one with another by means of the pipes 33. The digestion chambers are embedded in heat insulating material so that radiation loss is reduced.

It will be evident that chambers of various shapes and forms may be employed instead of those set forth herein so long as they serve the function of the chambers 32. The tubes of the series 4 preferably are filled with suitable catalytic material 4' which also may be the case with the rising series 11, although the uppermost of these are sometimes left open but the lower tubes thereof often may carry suitable catalytic material to advantage. In order to secure a greater heat conductivity, especially when the pipes or tubes are large in size, nickel, iron or steel balls, disks or irregular shaped metal fragments and the like may be used more or less throughout the tubular system in order to secure a more rapid decomposition and transfer of heat and some or all of the pipes may be equipped with fins as shown in the lowermost tube of the heating series 4.

It is one consideration of the present invention to secure a high heating efficiency from the fuel used in the apparatus and to this end a regenerative effect is secured by building the apparatus 1 of considerable height, or when the same principles of construction are carried out with a horizontal heater, then such heater should be of considerable length in order to secure a regenerative effect due to the cold or relatively cool charge entering the uppermost pipe 4 and passing down to a hotter zone so that the hottest flame or products of combustion come in contact with the lowermost tubes which thus are kept hottest; while the spent products of combustion pass upwardly in contact with the cooled tubes in the upper portion of the heat chamber 1 where the last available heat values may be largely absorbed and utilized.

The tubular rising series 11 in contrast with the descending series 4 extends from the zone of high temperature into one of relatively low temperature so that while the flow of the material along the series 4 is into zones of higher and higher temperature that of the material in the series 11 is into zones of lower and lower temperature, so that while series 4 is functioning as a decomposition system, the rising series 11 serves more as a digesting and equilibrium effecting system, an effect which may be secured to a greater or less degree, according to circumstances, by the digesting boxes 32. The heat decomposition of petroleum oil normally gives rise to various unsaturated products and the gasolene resulting from treatment of this character is unstable. By allowing the constituents of the materials formed by reaction to digest in the space afforded a satisfactory quality of gasolene is obtained.

It should, of course, be understood that the production of gasolene from kerosene or other fraction of petroleum, or for that matter from crude oil and various distillates, involves a splitting up of heavy molecules into molecules of lower molecular weight often with the simultaneous generation of hydrogen and other gases and the production of carbon, soot and tar. It is important to minimize the production of coke, soot and tar as these block the heating pipes more or less and when a catalyzer is used are liable to coat the surface thereof and impair its efficiency. The hydrogen which is set free by the decomposition should be given an opportunity to recombine which is entirely possible in view of the fact that unsaturated bodies are produced during the splitting operation. When water is introduced into the apparatus the steam reacts in the hotter zone under certain conditions yielding its hydrogen in an available form which is useful. The oil and the water, in case the latter is used, may be delivered to the apparatus in the form of vapor if desired.

Preferably I adjust conditions to provide a temperature for the escaping gases leaving the heating chamber 1 that shall range between 150° C. and 250° C. In the lower portion of the heating apparatus I prefer a temperature several hundred degrees higher, preferably between 400° C. and 600° C., depending on the oil employed. For kerosene boiling from about 150° C. upward, a temperature of about 500° C. in the lower sections is recommended. Heavy fractions

which require high temperatures to decompose may be superheated to 600 or 800° C. or so in the lower heating tubes and may then pass upward through risers 11 into zones of progressively decreasing temperature while equilibrium is being established, or may be passed into digesting chambers 32 for like purposes.

The oil products under treatment are vaporized in the system of tubes 4 between the upper and lower tubes, the point at which vaporization begins and is completed depending upon the temperatures maintained in the heating chamber 1. The temperatures herein indicated for the preferred treatment of kerosene and heavier fractions effect their vaporization at a position or positions in the system such that the resulting vapors travel for a substantial distance through a zone of progressively increasing temperature and the temperatures indicated are preferred both for effecting the heat decomposition of the materials specified and for stabilizing by digestion as hereinbefore described, the resulting lighter products, the rate of flow of the liquid through the upper portion of the system of tubes 4 and vapors through the lower portion of such system and through tubes 11 depending upon the particular material under treatment, such rate of flow being controlled according to the experience of the operator with the particular material under treatment as will be understood by those skilled in the art.

By this method of treatment 50 to 75% of a gasolene or light volatile spirit boiling below 150° C., is obtainable from the raw oil material taken, the residue being both gas and other heavy oil products which pass through the system several times without being broken down at the temperatures employed, because of their peculiar resistance to heat. Or in the case of some oils, the final products should be 75° or higher of gasolene or light spirit, the remainder of the oil being converted into gas. By carefully regulating the temperature and especially by giving the vapors a sufficiently long exposure to moderate heat, much less gas is produced than where the heat is sudden, violent and excessive. Thus by careful regulation and using preferably oils which have been fractionated fairly closely the amount of gas produced is very small indeed and the bulk of the oil is converted into light spirit.

What I claim is:

1. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition to a progressively decreasing temperature without substantial and material condensation until equilibrium of the unstable components of such products is established.

2. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through a zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition to a progressively decreasing temperature without substantial and material condensation until equilibrium of the unstable components of such products is established.

3. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated catalyzing zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition to a progressively decreasing temperature without substantial and material condensation until equilibrium of the unstable components of such products is established.

4. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition as vapors to a progressively decreasing temperature in the presence of catalytic material until equilibrium of the unstable components of such products is established.

5. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition as vapors to a progressively decreasing temperature until equilibrium of the unstable components of such products is established in then condensing said products, substantially freeing same from gas and returning the heavier-than-gasolene components to a decomposing zone.

6. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through a zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition as vapors to a progressively decreasing temperature until equilibrium of the unstable components

of such products is established in then condensing said products, substantially freeing same from gas and returning the heavier-than-gasolene components to decomposing zone.

7. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated catalyzing zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition as vapors to a progressively decreasing temperature until equilibrium of the unstable components of such products is established in then condensing said products, substantially freeing same from gas and returning the heavier-than-gasolene components to decomposing zone.

8. The process of making gasolene-like material which comprises passing the vapors of an oil containing essentially petroleum products heavier than gasolene through an elongated zone of progressively increasing temperature maintained at or above the decomposing temperature and in thereafter subjecting the products of such decomposition as vapors to a progressively decreasing temperature in the presence of catalytic material until equilibrium of the unstable components of such products is established in then condensing said products, substantially freeing same from gas and returning the heavier-than-gasolene components to decomposing zone.

9. The process of making gasolene-like material which comprises subjecting the vapors of an oil containing essentially petroleum products heavier than gasolene to a decomposing temperature and subjecting the products of such decomposition to digestion at an elevated temperature but below a decomposing temperature, until substantial equilibrium of the unstable components of said products is established and substantially stable gasolene material is obtained.

Signed at Montclair in the county of Essex and State of New Jersey this 18th day of April A. D. 1913.

CARLETON ELLIS.

Witnesses:
B. M. ELLIS,
F. CARBULT.

3254

N. W. THOMPSON.

PUMP.

APPLICATION FILED MAY 11, 1916.

1,250,050.

Patented Dec. 11, 1917.

3 SHEETS—SHEET 1.

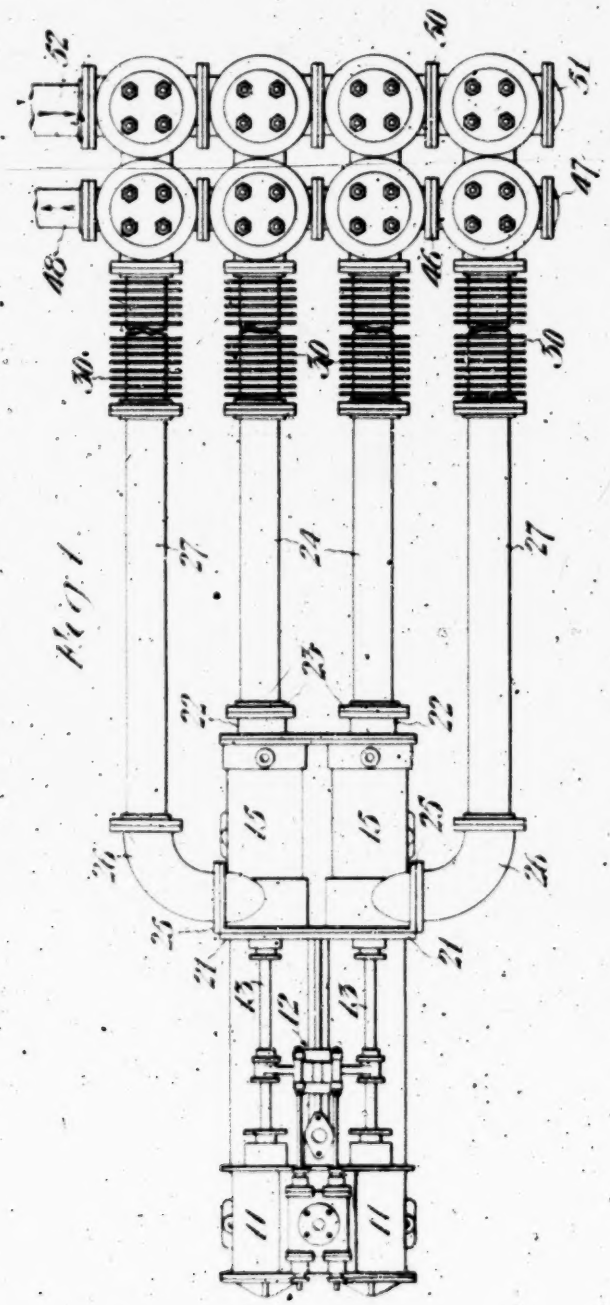

FIG. 1.

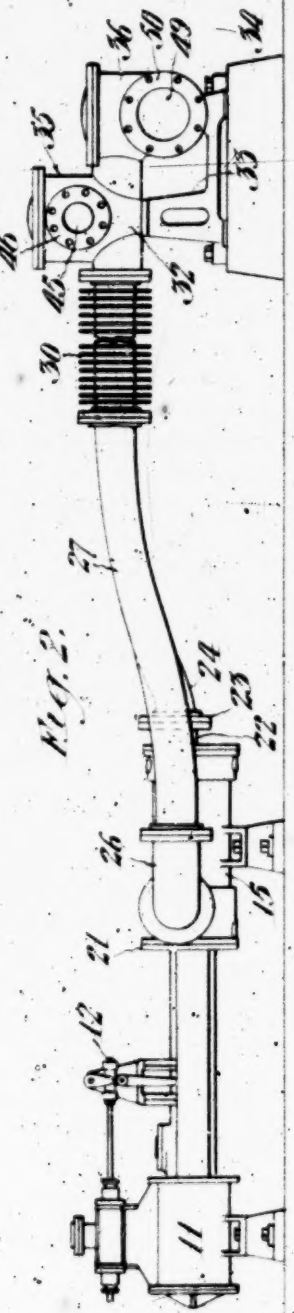

FIG. 2.

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3256

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1,250,050.

Patented Dec. 11, 1917.

3 SHEETS—SHEET 2.

Fig. 3.

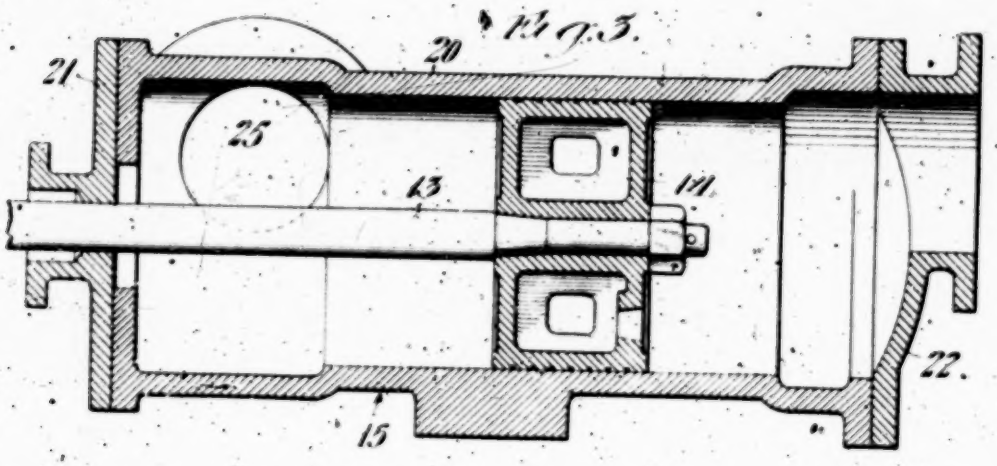
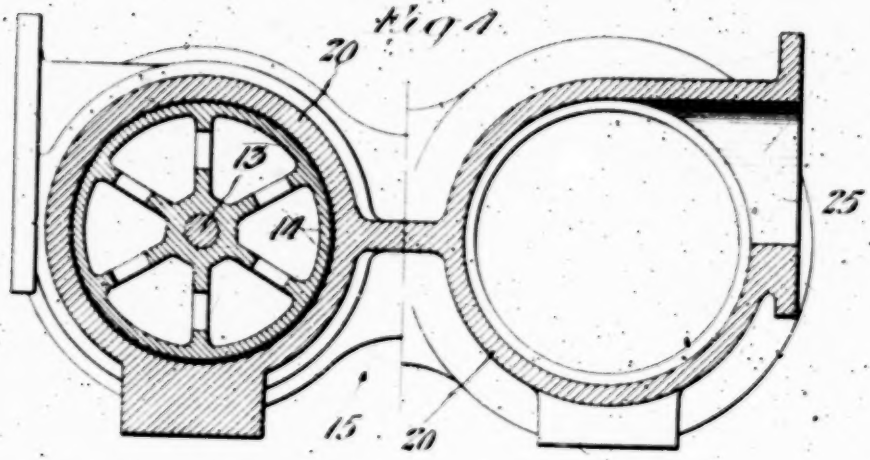


Fig. 4.



Inventor

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3258

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APPLICATION FILED MAY 11, 1916.

1,250,050.

Patented Dec. 11, 1917.

3 SHEETS—SHEET 3.

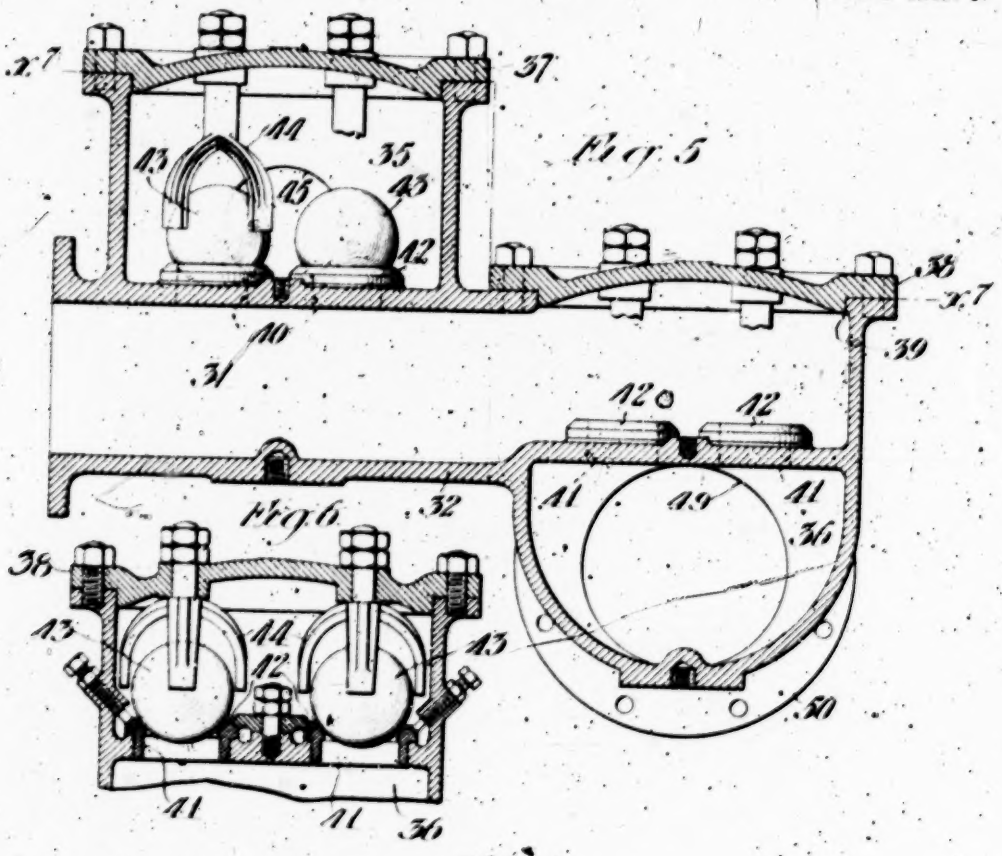

Fig. 5

Fig. 6

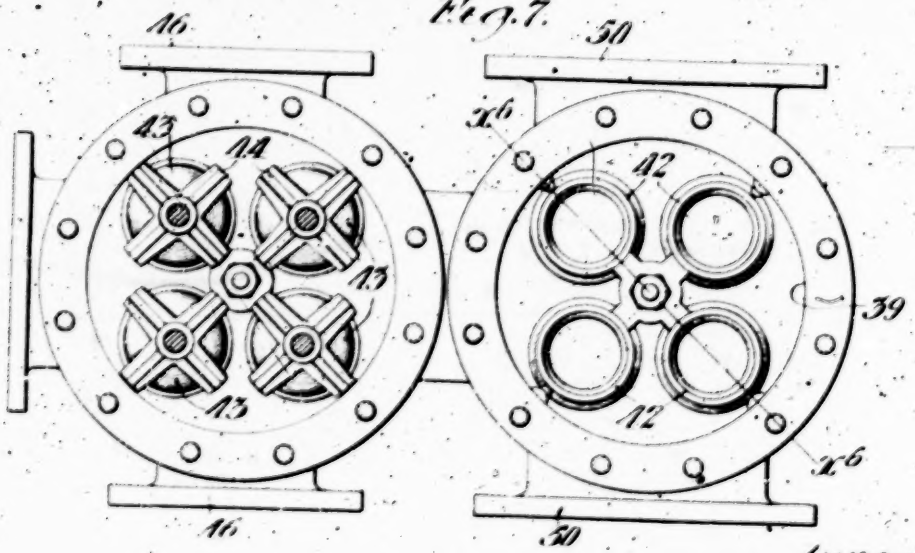

Fig. 7.

Inventor
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Townsend Graham & Clarke

UNITED STATES PATENT OFFICE.

NELSON W. THOMPSON, OF OAKLAND, CALIFORNIA, ASSIGNOR TO SIMPLEX REFINING COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

PUMP.

1,250,030. Specification of Letters Patent. Patented Dec. 11, 1917.

Application filed May 11, 1916. Serial No. 96,360.

To all whom it may concern:

Be it known that I, NELSON W. THOMPSON, a citizen of the United States, residing at Oakland, in the county of Alameda and State of California, have invented a new and useful Pump, of which the following is a specification.

My invention relates to pumps, and the principal object of my invention is to provide a pump which may be used to pump hot oil.

In the process of refining petroleum oils, it is found that if the oil is forced through suitable apparatus at temperatures of 600° F. or more, and at high pressures, that certain important changes can be made in the character of the oil. It is, however, difficult to maintain packing under pressure at this temperature, and ordinary piston or plunger pumps cannot be maintained in service for any length of time under these conditions. It is for this particular service that my invention is mainly intended, but it obviously can be applied to many other analogous uses.

In the drawings, which are for illustrative purposes only:

Figure 1 is a plan view of a pump embodying my invention.

Fig. 2 is a side elevation of same.

Fig. 3 is a central section through one of the pump cylinders.

Fig. 4 is a section on a broken plane through the pump cylinders.

Fig. 5 is a section through one of the valve chambers.

Fig. 6 is a partial section on a plane represented by the lines x^6—x^6 of Fig. 7.

Fig. 7 is a section on a plane represented by the line x^7—x^7 of Fig. 5, the ball retainers and balls being removed from the right hand chamber to better illustrate the invention.

In these drawings, a duplex double acting steam pump is shown. This pump consists of steam cylinders 11 provided with suitable valves and valve gears 12. Piston rods 13 are reciprocated by the steam in the cylinders 11, the parts 11, 12 and 13 being old in the art and requiring no special description. A motor driven mechanism may be substituted therefor if desired, the only essential feature being that the piston rods 13 are reciprocated by suitable power driven means.

Each of the piston rods 13 passes through a suitable packing and connects to a piston 14 sliding in a pump cylinder 15. These pump cylinders are right and left handed with relation to each other, each consisting of a main casting 20, a stuffing box head 21, and water head 22. Each of the water heads is connected by flanges 23 with one of two pipes 24. Side outlet openings 25 are connected through elbows 26 with pipes 27. The opening 25 and the opening through the water head 22 are located with their upper ends flush with the top of the cylinder.

Each of the pipes 25 and 27 is connected to a cooling means 30. In the drawing, this is a long pipe provided with external flanges for air cooling. Water cooling may be provided if desired.

Each of the cooling means 30 is connected to a pump passage 31 in a valve body 32, each of the valve bodies being carried on a frame 33 resting on a base 34. Located above the pump passage in each valve body 32 is a pressure chamber 35, and located below the pump passage 31 is a suction chamber 36. A cover 37 closes the top of each pressure chamber 35, and a cover 38 closes an opening 39 in the upper wall of the passage 31 just over each of the suction chambers 36.

Openings 40 connect each pressure chamber 35 with its corresponding passage 31, the passages 31 each being connected through openings 41 with a corresponding suction chamber 36. Suitably secured in each of the openings 40 and 41 is a valve seat 42 on which a ball valve 43 is normally seated, the balls having a limited movement in cages 44, the cages being secured in and carried by the covers 37 and 38.

Openings 45, provided with flanges 46, are provided on each side of each pressure chamber and are so arranged that the valve bodies 32 may be clamped together, so that all the pressure chambers are in open communication with each other, the chambers forming a pressure manifold. A cover 47 closes one end of this manifold and a pressure pipe 48 connects to the other end.

Openings 49, provided with flanges 50, are provided on each side of each suction chamber, these flanges also being so placed as to be readily connected so that all the suction chambers 36 are connected together to form a suction manifold, one end of which is closed by a cover 51 and the other end of

which is connected to a suction pipe 52. The cover 47 and the pipe 48, and the cover 51 and the pipe 52 may be readily interchanged if desired.

The valve bodies 32 are somewhat higher than the cylinders 15, and the pipes 24 and 27 and the cooling means 30 are so inclined that their highest point is where they connect to the passages 31.

I attach a peculiar importance to this feature of my invention, as it prevents air or gas pockets being formed which would tend to cut down the capacity and efficiency of the pump.

The method of operation is as follows:

The entire interior of the pump is filled with oil, which can conveniently be accomplished by feeding oil under slight pressure through the suction pipe 52. Steam is then turned into the cylinders 11, being controlled by the valve gear 12. The piston rods 13 then reciprocate the pistons 14 so that the contents of each end of the cylinder are alternately increased or diminished. This forces oil in or out of the pipes 24 or 27 and in and out of the cooling means 30 and the passage 31. On the suction stroke for either end of either of the cylinders 15, a slight vacuum may be caused in the passage 31, or the pressure therein may be so relieved that hot oil from the suction manifold flows through the openings 41 into the passage 31, the balls 43 lifting from their seats to allow this. On the pressure stroke, hot oil from the passage 31 flows through the openings 40 into the pressure manifold, the balls 43 lifting from the seats 42 to allow this. The balls 43 prevent any return of hot oil through either the openings 40 or 41.

The internal capacity of the cooling means 30 is made large with relation to the capacity of the cylinders 15. On each suction stroke a volume of hot oil equal to the cylinder capacity is drawn into the cooling means 30. This oil mixes in a measure with the oil already in the cooling means 30, tending to heat same, and on the pressure stroke an equal volume of the mixture is ejected. The oil in the cooling means 14 is hottest nearest the passage 31 and is cool enough in the cylinders to allow the piston to work under ordinary temperature conditions.

I claim as my invention:—

1. In a pump, a cylinder, a valve body having a pump passage therein, walls forming a pressure manifold above said passage, a pressure valve between said passage and said manifold, walls forming a suction manifold below said passage, a suction valve between said manifold and said passage, and cooling means connecting the interior of said cylinder with said pump passage.

2. In a pump, a cylinder, a valve body having a pump passage therein, walls forming a pressure manifold above said passage, a pressure valve between said passage and said manifold, walls forming a suction manifold below said passage, a suction valve between said manifold and said passage, and cooling means connecting the interior of said cylinder with said pump passage, said parts being so arranged that said pressure valve is at the highest point in said cylinder, said valve body, or said cooling means.

In testimony whereof, I have hereunto set my hand at San Francisco, California, this 4th day of May, 1916.

NELSON W. THOMPSON.

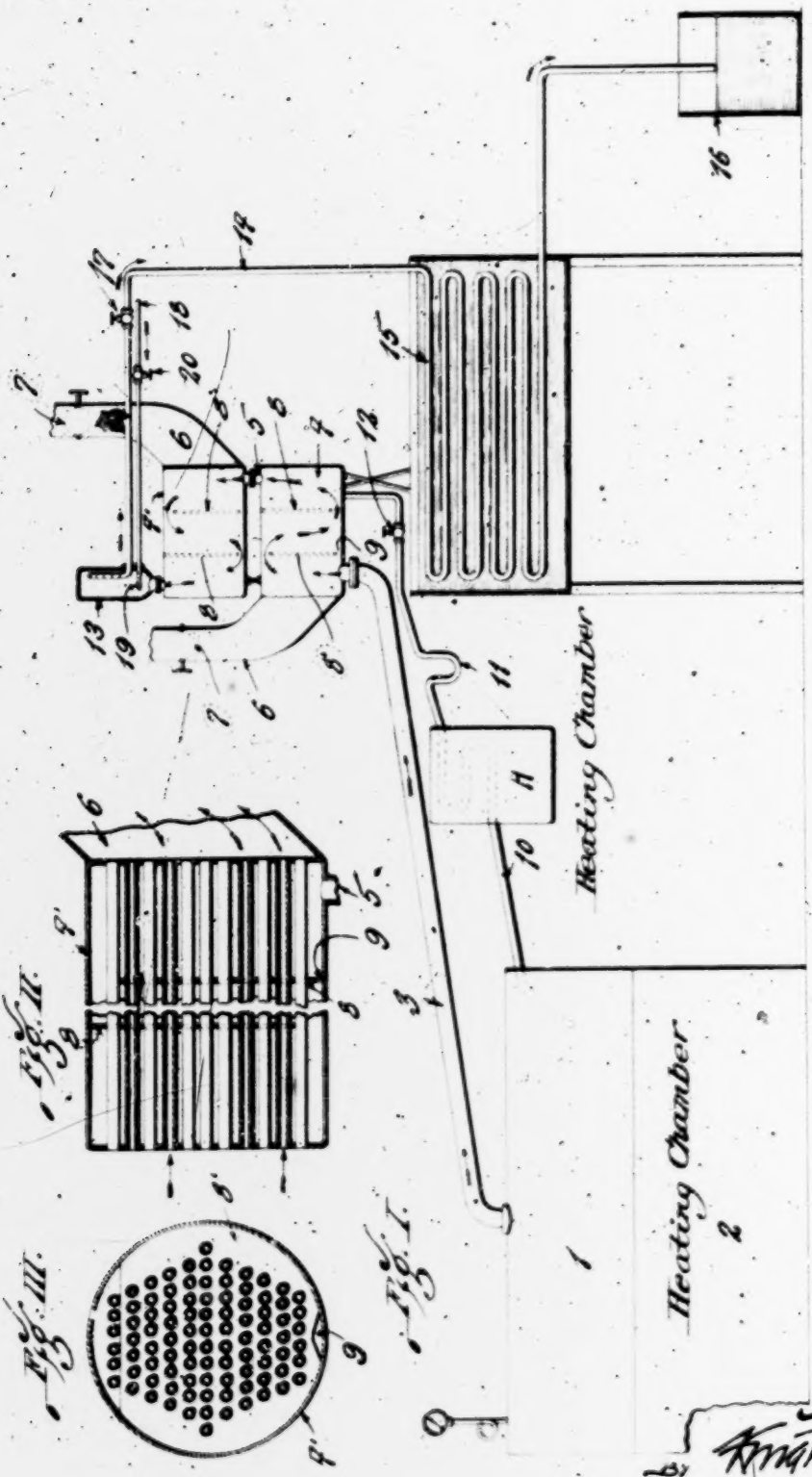
3262

J. W. COAST, Jr.

ART OF CRACKING PETROLEUM HYDROCARBONS.

APPLICATION FILED DEC. 11, 1916.

1,250,799. Patented Dec. 18, 1917.



INVENTOR
J. W. COAST, Jr.
BY Knight Bros
ATTYS

3263

UNITED STATES PATENT OFFICE.

JOHN W. COAST, JR., OF TULSA, OKLAHOMA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE PROCESS COMPANY, A CORPORATION OF MARYLAND.

ART OF CRACKING PETROLEUM HYDROCARBONS.

1,250,799. Specification of Letters Patent. Patented Dec. 18, 1917.

Application filed December 11, 1916. Serial No. 136,229.

To all whom it may concern:

Be it known that I, JOHN W. COAST, Jr., a citizen of the United States of America, a resident of Tulsa, in the county of Tulsa, State of Oklahoma, have invented certain new and useful Improvements in the Art of Cracking Petroleum Hydrocarbons, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

My invention relates to improvements in the art of cracking petroleum hydrocarbons to obtain a gasolene substitute adapted for use in internal combustion engines. One of the objects is to improve the prior art by providing a method whereby high boiling petroleum distillates or residues, or a mixture including such distillates or residues, may be cracked, vaporized and condensed very rapidly, with the result of obtaining a high grade low boiling product. In the preferred form of the invention, the highly desirable product is obtained by a single cracking operation, it being unnecessary to subject the product to a multiplicity of distilling operations. However, the quality of the product may, of course, be improved by fractional distillation.

More specifically stated, the preferred method comprises the step of condensing and returning to the retort, a large volume of high boiling hydrocarbons, and conducting the relatively small volume of low boiling hydrocarbons to the main condenser from which the low boiling product is recovered. The contents of the retort are subjected to such a high temperature that the liquid vaporizes very rapidly, and a large volume of uncracked high boiling hydrocarbons, therefore, pass from the retort to the primary or reflux condenser where they are condensed and prevented from passing to the main condenser. The vaporized low boiling hydrocarbons pass from the primary or reflux condenser to a steam chamber where they are acted upon by a spray of relatively cool steam. The steam condenses an intermediate fraction, and almost entirely eliminates the objectionable odor and color usually present in cracked products. For reasons which at this time I am unable to fully explain, the product is otherwise very materially improved by the introduction of steam into the light hydrocarbon vapors which pass through the primary condenser. To obtain these advantages, the primary condenser and the steam chamber must be maintained under a high degree of pressure, and it is also desirable to condense the product under about atmospheric pressure. I, therefore, conduct the vapors from the retort, first through the primary condenser under a high pressure, thereby condensing and returning the high boiling fractions. The remaining vapors are then conducted, while under the high pressure, into the steam chamber where they are acted upon by the steam, the intermediate fractions being condensed by the relatively cool steam and returned to the primary condenser. After passing successively through the primary condenser and steam chamber, under a high pressure, the vaporized low boiling hydrocarbons are preferably conducted with the steam to a main condenser maintained at about atmospheric pressure.

Figure I is a diagrammatical view of an apparatus adapted for use in carrying out my method.

Fig. II is a fragmentary section of one of the air cooled condensers.

Fig. III is a transverse section of the condenser shown in Fig. I.

To illustrate the invention I have shown a retort or still 1 arranged over a heating chamber 2. The primary condenser preferably comprises an air cooled vapor pipe 3 leading from the retort to an air cooled drum 4, the latter being connected by a short pipe 5 to another air cooled drum 4'. Each of these drums is provided with horizontal tubes, open at their ends and communicating with a hot air flue 6. Dampers or valves 7, arranged in the air flue, may be adjusted to regulate the circulation of air through the tubes in the drums 4 and 4'. 8 and 8' designate deflector plates arranged in the air cooled drums to direct the vapors in the direction indicated by arrows. An opening 9 is formed at the lower edge of each deflector plate 8' to allow the condensate to flow backwardly, toward the retort. A return pipe 10, leading from the condenser 4 to the retort 1, is provided with a trap 11 and a valve 12.

The vapors passing from the drum 4' are conducted into a steam chamber 13, and the vapors flowing from said chamber 13 pass through a vapor pipe 14 to a secondary or

main condenser 15, the low boiling product being discharged into a reservoir 16. A pressure regulating valve 17 arranged in the vapor pipe 14 may be regulated to maintain a predetermined pressure in the steam chamber 13, also in the retort 1 and primary condensing elements 3, 4 and 4'. A steam pipe 18 is connected to a discharge member 19 in the steam chamber 13. The flow of steam may be regulated by adjusting a valve 20.

Although I have shown and described a specific structure adapted for use in following my method, it is to be understood that the illustration is merely diagrammatical and that any suitable apparatus may be used in carrying out the method herein claimed.

The new method may be followed in cracking various heavy hydrocarbon products resulting from the treatment of crude petroleum, particularly such inexpensive hydrocarbons having a boiling point higher than 350° F., the most beneficial results being obtained from hydrocarbons having a boiling point ranging from 450° F. to 700° F. The substances to be treated are introduced into the retort in any suitable manner, and the valve 17 is adjusted to obtain the desired pressure in the retort, primary condenser and steam chamber 13. The pressure may range from 50 to 150 pounds per square inch, or even higher, but it is preferably maintained at about 80 pounds per square inch. The contents of the retort are subjected to such a high degree of heat that the liquid will vaporize rapidly. This temperature may range from about 600° F. to 800° F., and is preferably maintained at about 715° F. to 750° F. The pressure in the apparatus is due to the expansive force of the vapors.

Owing to the intense heat and the rapid vaporization, a large volume of high boiling hydrocarbons flow from the retort into the primary condensing devices 3, 4 and 4', and since these devices are in a higher plane than the retort, a large volume of condensate will return, by gravity, through the inclined pipe 3 to the retort. If desired, the valve 12 may be opened to permit the flow of condensate from the air cooled drums 4 and 4' to the retort. To obtain the desired low boiling product, about one-half of the vapors may be condensed in the air cooled primary condensing devices, and additional condensation will take place in the steam chamber 13 above the air cooled drum 4'. Relatively cool steam, preferably saturated steam, is discharged from the steam pipe 18 into the discharge member 19, the latter having a number of small discharge ports so as to discharge a multitude of fine streams of steam into the stream of vapors in the steam chamber. The steam is superheated by the vapors, and the relatively heavy hydrocarbons are condensed by the cooling action of the steam. The steam commingles with and acts upon the light hydrocarbon vapors which pass entirely through the primary condensing devices, the high boiling hydrocarbons being condensed before the vapors reach the steam chamber. It is also important to note that the steam is introduced into the vapors at a point where the vapors are under the high degree of pressure maintained between the valve 17 and the retort.

The mixture of steam and hydrocarbon vapors, under pressure, passes from the steam chamber 13 to the vapor pipe 14. The pressure is relieved at the pressure regulating valve 17 and the mixed vapors are afterward condensed, under about atmospheric pressure, in the main condenser 15. The water and low boiling hydrocarbon product, recovered from the condenser 15, may be separated from each other in any suitable manner.

The return conductor 10 passes through a heating chamber H so as to heat the condensate before it reaches the hot liquid in the still. This condensate is preferably heated to about the temperature of the contents of the still or retort 1.

The apparatus herein shown is claimed in an application for patent filed by me on Dec. 18, 1916, Serial Number 137,578. The air cooled condenser *per se* and the particular method of conducting air and vapor through a condenser of this kind, are claimed in applications for patents filed by me May 31, 1917, Serial Number 172,037, and May 22, 1917, Serial Number 170,150, respectively. The use of steam as herein disclosed is more broadly claimed in an application for patent filed by me Oct. 23, 1916, Serial Number 127,128.

I claim:—

1. In the art of cracking petroleum hydrocarbons, the method which comprises heating said hydrocarbons, confining the resultant vapors under a pressure greater than two atmospheres, conducting said vapors, while under pressure, through a condenser, thereafter introducing steam into the remaining vapors while said vapors are confined under pressure, and condensing the steam and low boiling hydrocarbons.

2. In the art of cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, the method which comprises cracking such hydrocarbons in a retort under a pressure greater than 50 pounds per square inch, condensing the vaporized high boiling fractions under a pressure greater than 50 pounds per square inch, thereafter introducing relatively cool steam into the remaining vapors while said vapors are confined under a pressure greater than 50 pounds per square inch, conducting the mixture of steam and hydrocarbon vapors to a

main condenser, and maintaining the contents of said main condenser under a pressure of about one atmosphere.

3. In the art of cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, the method which comprises cracking such hydrocarbons in a retort under a pressure greater than 50 pounds per square inch, condensing the vaporized high boiling fractions under a pressure greater than 50 pounds per square inch, thereafter returning the high boiling fractions to the retort and introducing relatively cool steam into the remaining vapors while said vapors are confined under a pressure greater than 50 pounds per square inch, conducting the mixture of steam and hydrocarbon vapors to a main condenser, and maintaining the contents of said main condenser under a pressure of about one atmosphere.

4. In the art of cracking high boiling petroleum hydrocarbons to obtain a substitute for gasolene, the method which comprises heating such high boiling hydrocarbons in a retort, conducting vapors from said retort first through an air cooled reflux condenser, and then through a steam chamber, conducting saturated steam to said steam chamber and introducing the steam into the stream of vapors in the steam chamber, thus condensing high boiling fractions and at the same time superheating the steam, returning high boiling hydrocarbons, in the form of condensate, from said steam chamber to said air cooled reflux condenser and from the last mentioned condenser to the retort, at the same time maintaining the contents of said retort, condenser and steam chamber under a pressure greater than 50 pounds per square inch, conducting the mixture of steam and low boiling hydrocarbons from said steam chamber to a main condenser, and maintaining the contents of said main condenser under about atmospheric pressure.

JOHN W. COAST, Jr.

3268

J. J. CURRAN.

PRESSURE STILL.

APPLICATION FILED MAY 25, 1917.

1,255,714.

Patented Feb. 5, 1918.

3 SHEETS—SHEET 1.

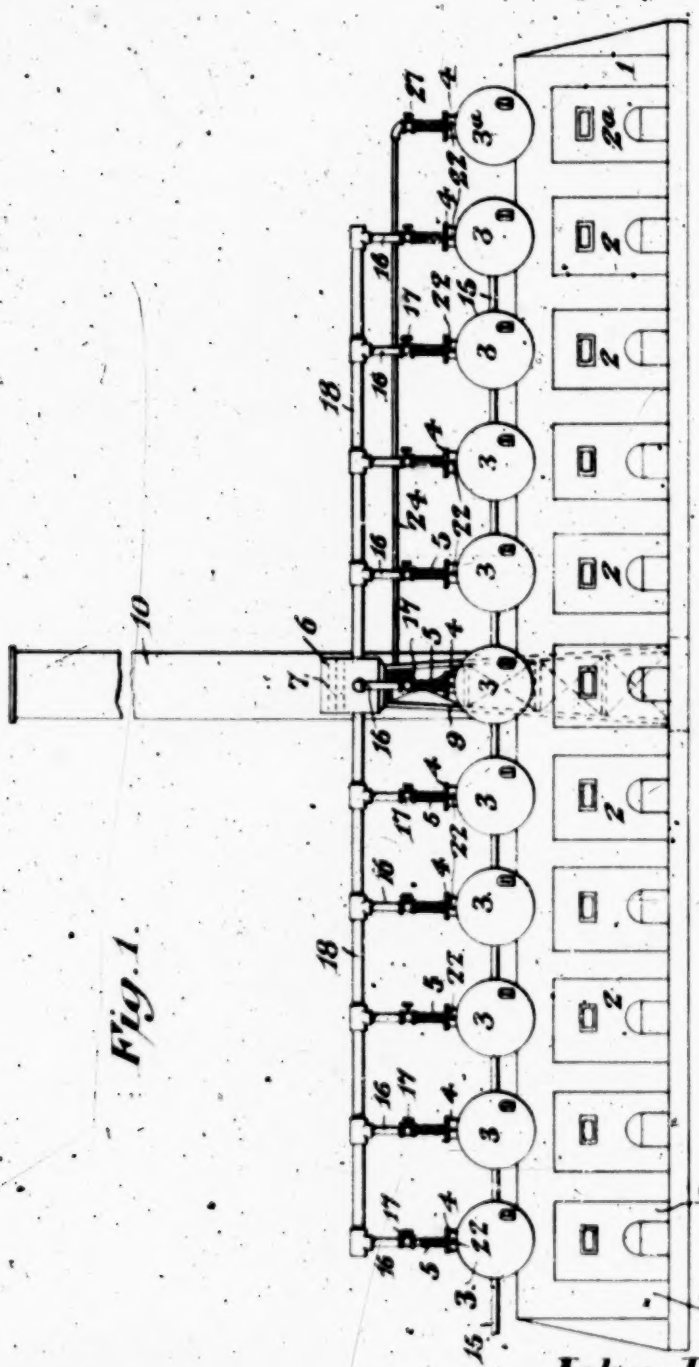


Fig. 1.

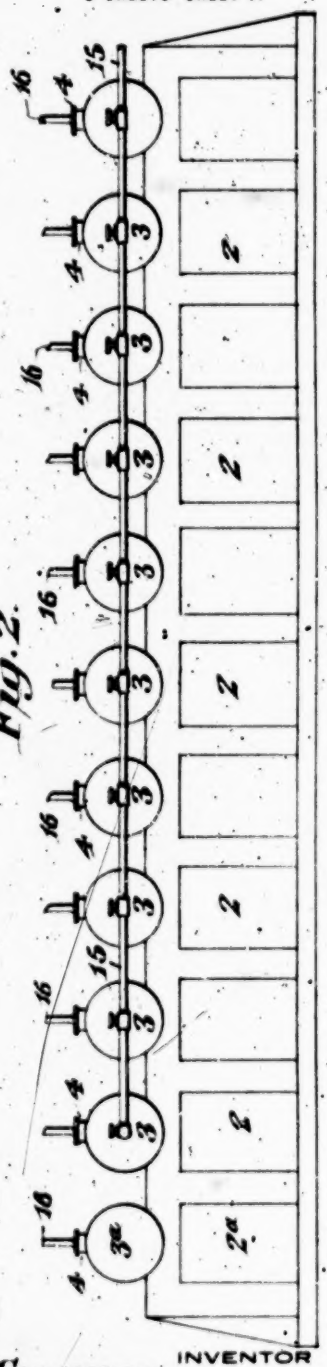


Fig. 2.

WITNESSES

Jas. F. McCathran

F. T. Chapman

INVENTOR

John J. Curran,

BY E. G. Siggers

ATTORNEY

3270

J. J. CURRAN.

PRESSURE STILL.

APPLICATION FILED MAY 25, 1917.

1,255,714.

Patented Feb. 5, 1918.

3 SHEETS—SHEET 2.

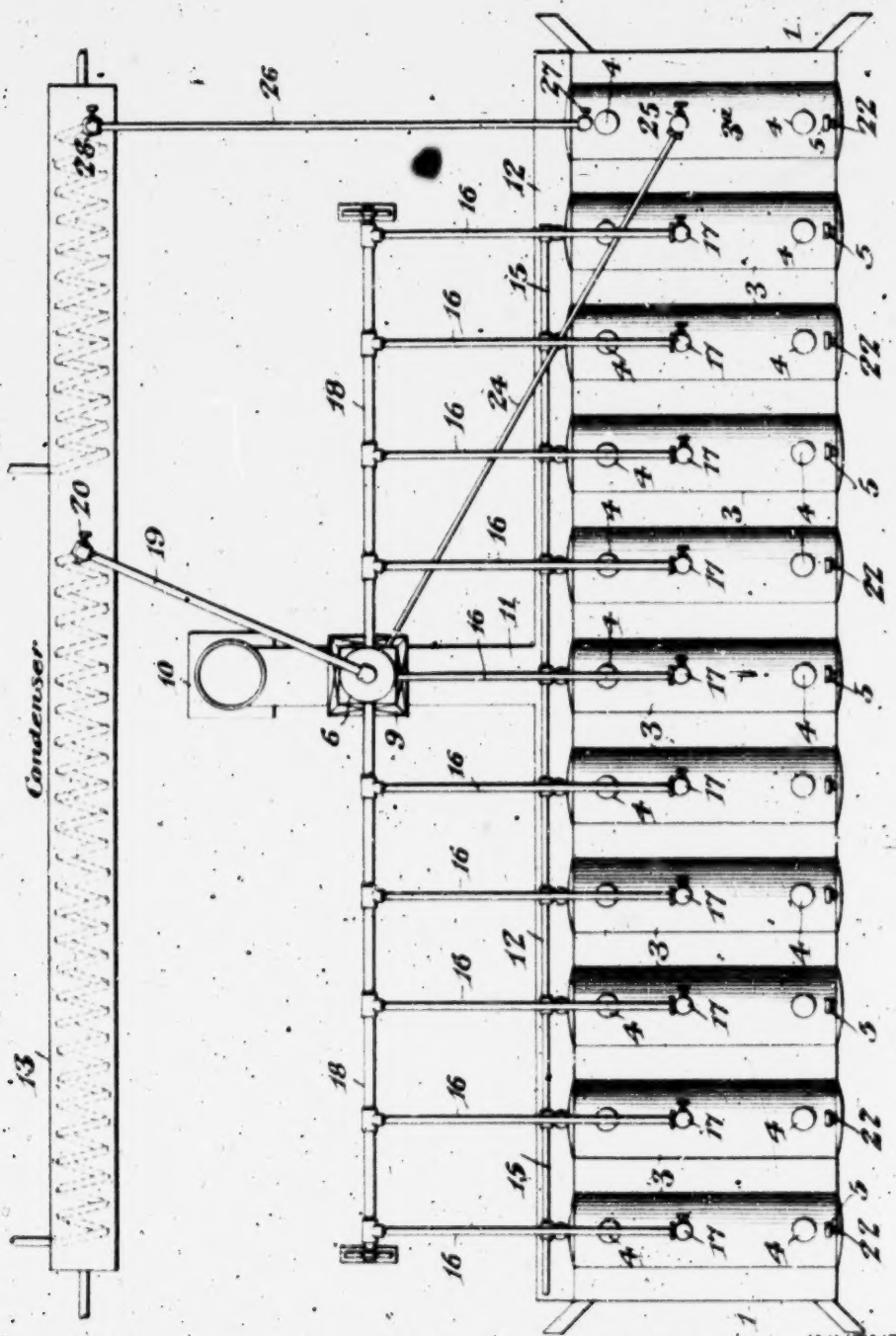


Fig. 3.

WITNESSES

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3272

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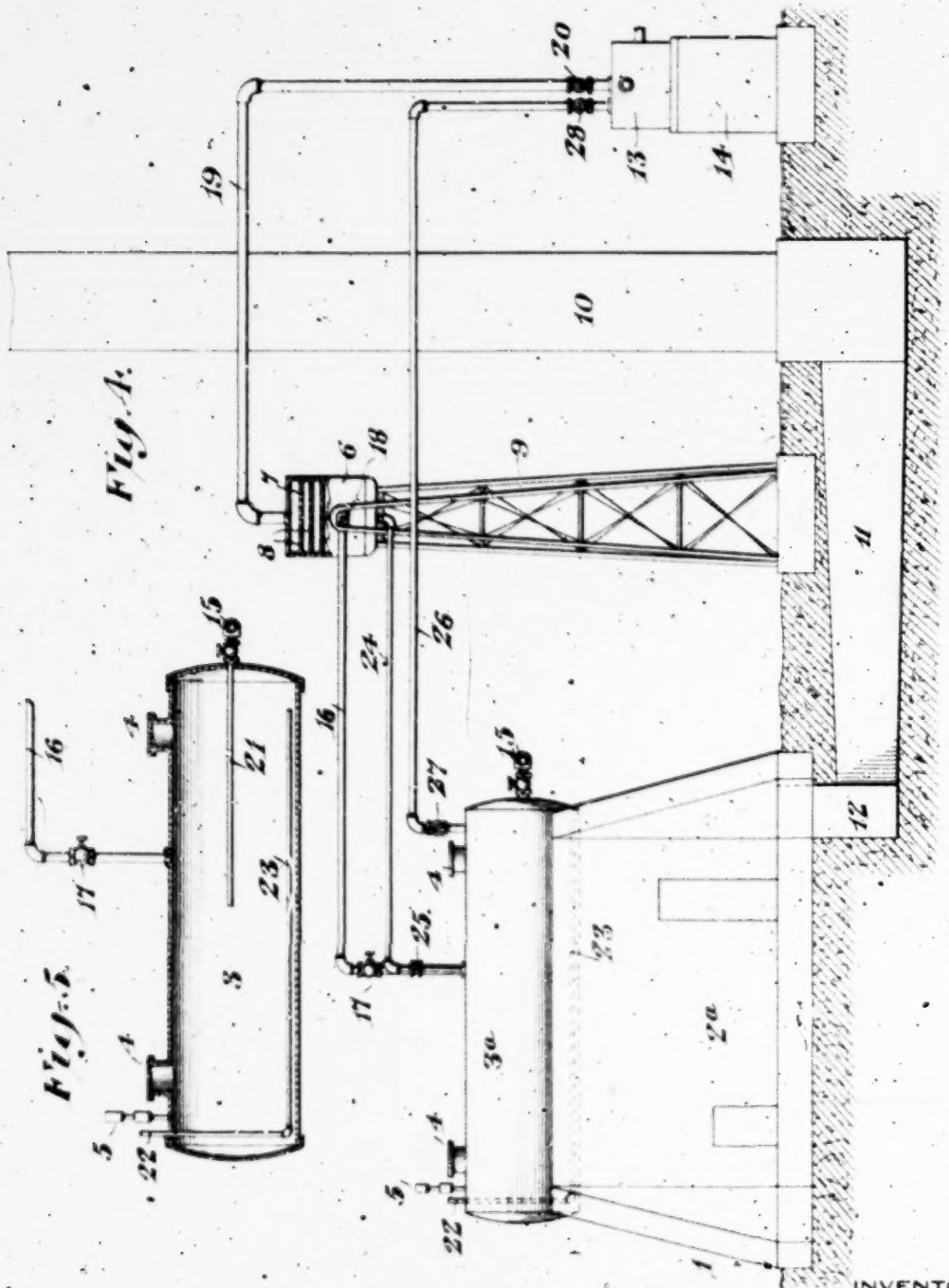
PRESSURE STILL.

APPLICATION FILED MAY 25, 1917.

1,255,714.

Patented Feb. 5, 1918.

3 SHEETS—SHEET 3.



WITNESSES

Jas. H. McCathran

T. J. Shipman

INVENTOR

John J. Curran,

BY E. G. Siggers

ATTORNEY

UNITED STATES PATENT OFFICE.

JOHN J. CURRAN, OF AUGUSTA, KANSAS.

PRESSURE-STILL.

1,255,714. Specification of Letters Patent. Patented Feb. 5, 1918.

Application filed May 25, 1917. Serial No. 170,905.

To all whom it may concern:

Be it known that I, JOHN J. CURRAN, a citizen of the United States residing at Augusta, in the county of Butler and State of Kansas, have invented a new and useful Pressure-Still, of which the following is a specification:

This invention has reference to pressure stills for obtaining gasolene or benzene from gas oil, fuel oil, and the like.

The invention comprises a battery of stills arranged to discharge into a separating tank and associated with the battery of stills is another still receiving residuum from the separating tank for redistillation, the result being that there is a conservation of material and of energy employed in treating the material.

The invention will be best understood from a consideration of the following detailed description, taken in connection with the accompanying drawings forming part of this specification, with the further understanding that while the drawings show a practical form of the invention, the latter is not confined to any strict conformity with the showing of the drawings, but may be changed and modified, so long as such changes and modifications come within the scope of the appended claims.

In the drawings:—

Figure 1 is a front elevation of the battery of stills, or tanks.

Fig. 2 is a rear elevation of the battery of stills omitting the condensing tank and stack.

Fig. 3 is a plan view of the battery of stills, the stack and the condensing tanks.

Fig. 4 is an end elevation with some parts broken away and in section.

Fig. 5 is a longitudinal diametric section of one of the stills.

Referring to the drawings, there is shown a structure 1 which may be a cement or other suitable building with a series of furnaces 2 therein. On the cement structure 1 above each furnace is a still 3 of elongated cylindrical shape similar in conformation to an ordinary steam boiler so far as the outer shell is concerned. At suitable points each still 3 is provided with manholes 4 which may follow the usual custom, but which are only diagrammatically indicated in the drawings. Each still is also provided with gages 5, whereby an operator may ascertain at any time the pressure conditions within the still.

At a suitable point adjacent to but spaced from the battery of stills is a drum 6 in which is located an upright series of horizontal baffle plates 7 through which are numerous perforations 8. It is desirable that the drum 6 be considerably elevated and higher than the stills 3, and, therefore, it may be supported by a tower 9 of any suitable construction, the drawings indicating a steel truss tower. The furnaces 2 all communicate with a stack 10 through suitable flues 11, 12, respectively, so as to dispose of the products of combustion produced in the furnaces.

There is also a condensing tank 13 for receiving the gas driven off from the gas oil, and this tank is mounted on a suitable foundation 14. The tank 13 is of the usual construction employed in condensers and needs no particular description. The condensed gasolene or benzene may be collected in any suitable manner.

The stills 3 are shown as arranged in a group of ten, although as before stated such particular number is not obligatory. There is also another still 3^a which may be mounted upon the same foundation 1 and is provided with a furnace 2^a similar to the furnaces 2.

All the stills 3 communicate with a supply pipe 15 and all are provided with outlet pipes 16 each containing a valve 17, the outlet pipes 16 in turn communicating with other or trunk pipes 18 leading into the drum 6 at a point below the perforated baffles 7. To the top of the drum 6 there is connected another pipe 19 which at the other end leads into the condenser tank 13 and contains a cut off valve 20. The drum 6 is arranged intermediately of the series of stills 3 and hence that still 3 midway of the length of the series has its pipe 16 directly entering the drum 6 instead of communicating therewith by way of the pipes 18. The pipe 15 enters the respective stills 3 through other pipes 21 which may be so arranged as to force the oil into the still in the form of a spray.

Each still has a steam pipe 22 entering it and provided with a coil or coils 23 extending along the bottom of the still within the latter.

The additional still 3^a is similar to the

stills 3 except that the pipe 15 does not communicate with it. Instead of such an arrangement there is a pipe 24 leading from the bottom of the drum 6 into the top of the still 3^a, and in this pipe there is interposed a cut off valve 25. Leading from the still 3^a is another pipe 26 with a valve 27 therein and this pipe leads and opens into the tank 13, near which the pipe is provided with a valve 28 like the valve 20 in the pipe 19. The still 3^a has manholes 4 and a gage 5 like the other stills.

Gas oil is driven into the stills 3 in any suitable manner through the pipes 15 and 21, entering these stills in the form of a spray. Heat is generated in the furnaces 2 of the stills 3 and may be supplemented by superheated steam entering the stills through the pipes 22 and 23. The heating is continued until about 150 pounds pressure, or even more, is produced in the stills, and then the valves 17 are opened and the gas is allowed to flow from the stills through the pipes 16 and 18 into the drum 6, where the light gases of benzene or gasolene pass through the pipe 19 and through the open valve 20 into the condenser 13 where the gases may be condensed and withdrawn. The heavier distillates pass through the pipe 24 and the then open valve 25 into the tank 3^a in the form of tars or heavy liquids, and in this tank the heavy matters are again cracked by the heat provided, the lighter distillates passing through the pipe 26 by way of the valves 27 and 28, which are then open, into the tank 13, thus adding to the accumulation of gasolene or benzene withdrawn therefrom.

The steam pipes in the stills may be used for steaming out the stills, or, as before stated may be employed for directing superheated steam into the stills to help build up the pressure therein.

The final still 3^a has the advantage of providing for a second cracking of the heavy residuum, thus saving the necessity of a separate tar still and the loss of heat and time in directing the heavy distillates into such a separate tar still. The usual practice of pumping out the residuum to a tar still causes loss of all the heat and a considerable loss of time. By the process of this invention it is feasible to recover the coke from the eleventh or last still and also save the light ends.

For instance, the stills permit obtaining about sixty-seven per cent. of benzene from each still and about twenty-eight per cent. of coke in the last still. The run back from all the stills in the line is to the eleventh still as common to the first ten stills.

What is claimed is:—

1. The combination with a battery of stills, each having means for heating it, means for feeding the material to be treated to the battery of stills, and a drum communicating with all the stills of the battery for receiving distillates therefrom, of an additional still associated with the battery of stills and fed from the drum, said additional still having means for heating it, and condensing means into which the drum and the last-named still deliver.

2. The combination with a battery of stills, each having means for heating it, means for feeding the material to be treated to the stills, and a drum common to the stills of the battery for receiving distillates therefrom and provided with perforated baffles to permit the rise therethrough of light distillates and the accumulation therein of heavy distillates, of an additional still associated with the battery of stills and having means for heating it, said additional still being in communication with the portion of the drum below the baffles to receive heavy distillates collected in the drum.

3. Means for the production of light hydrocarbon liquid from gas oils, comprising a battery of stills and furnaces, and an additional still and furnace therefor associated with the battery of stills and furnaces, a feed pipe connected in common to all the stills of the battery of stills, a drum common to all the stills of the battery of stills and connecting with each still through a valved discharge pipe individual to the still, said drum having means within it for separating light and heavy distillates, condensing means for light hydrocarbon gases communicating with the drum, a valved pipe connecting the portion of the drum receiving the heavy distillates with the separate still, condensing means for the separate still and a valved pipe connecting the separate still and condensing means therefor, the drum being of a height with respect to the separate still to permit gravitating of the heavy distillates from the drum to the still.

4. Means for the production of light hydrocarbon liquid from gas oils, comprising a battery of stills and furnaces, and an additional still and furnace therefor associated with the battery of stills and furnaces, a feed pipe connected in common to all the stills of the battery of stills, a drum common to all the stills of the battery of stills and connecting with each still through a valved discharge pipe individual to the still, said drum having means within it for separating light and heavy distillates, condensing means for light hydrocarbon gases communicating with the drum, a valved pipe connecting the portion of the drum receiving the heavy distillates with the separate still, condensing means for the separate still and a valved pipe connecting the separate

still and condensing means therefor, the drum being of a height with respect to the separate still to permit gravitating of the heavy distillates from the drum to the still, and all of the stills being provided with pipes for directing steam thereinto.

In testimony, that I claim the foregoing as my own, I have hereto affixed my signature in the presence of two witnesses.

JOHN J. CURRAN.

Witnesses:
G. A. CLEMENTS,
R. D. LAVENY.

3278

F. E. WELLMAN.

OIL REFINING APPARATUS.

APPLICATION FILED JULY 22, 1916.

1,273,966.

Patented July 30, 1918.

2 SHEETS—SHEET 1.

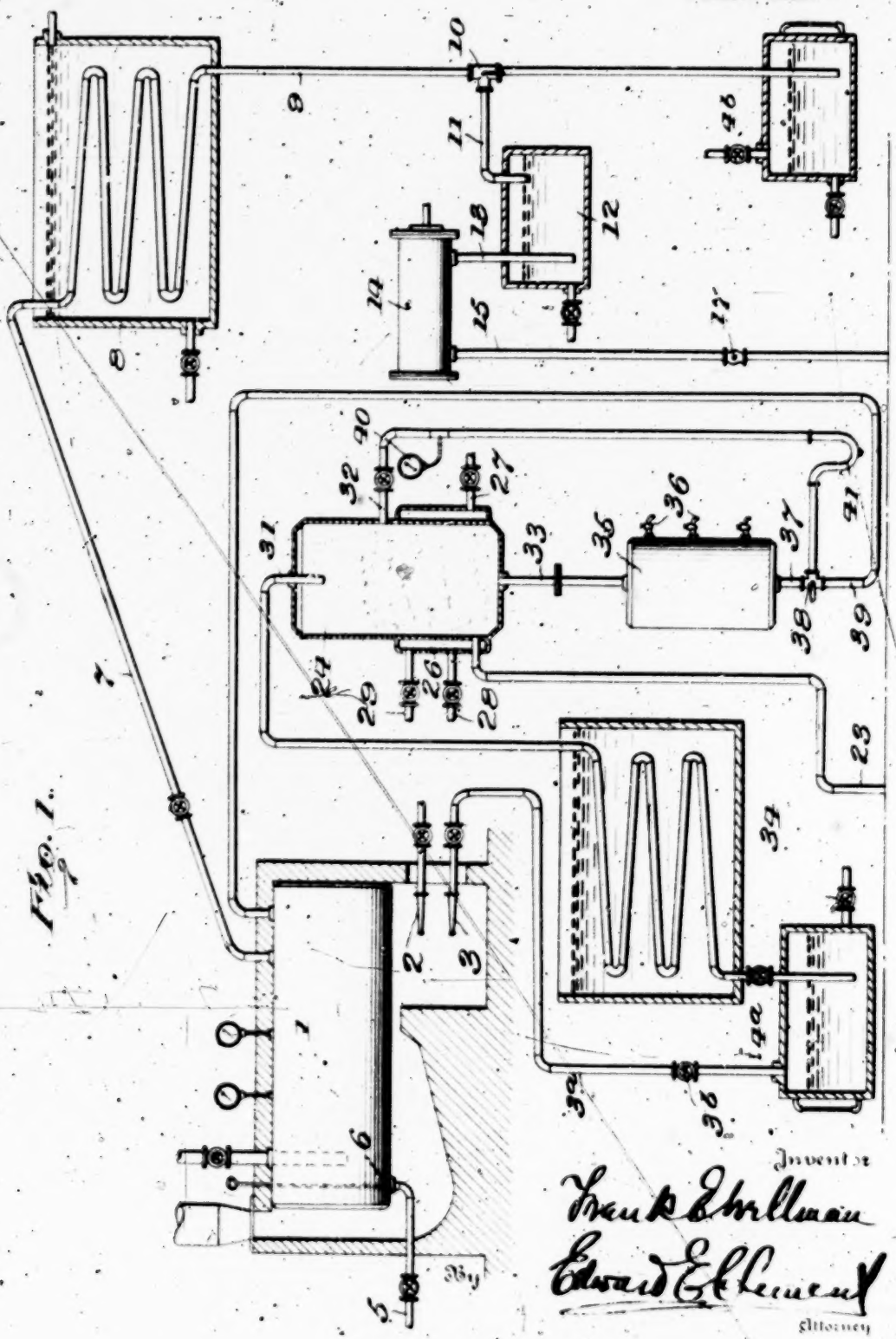


Fig. 1.

Inventor

Frank E. Wellman

Edward E. Clement

Attorney

3280

F. E. WELLMAN.

OIL REFINING APPARATUS.

APPLICATION FILED JULY 22, 1916.

1,273,966.

Patented July 30, 1918.

2 SHEETS—SHEET 2.

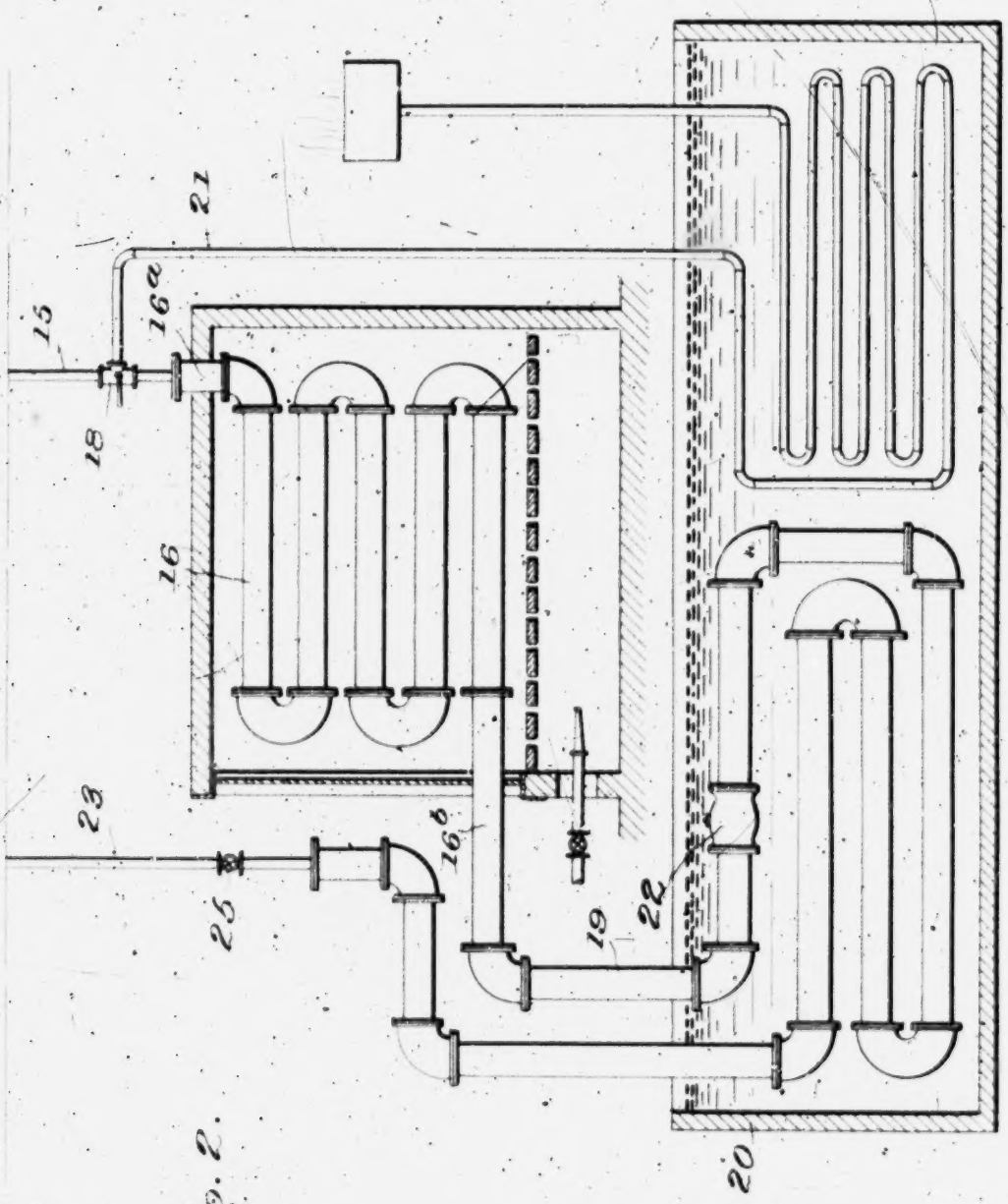


Fig. 2.

Inventor

Frank E. Wellman

By Edward E. Coleman

Attorney

UNITED STATES PATENT OFFICE.

FRANK E. WELLMAN, OF KANSAS CITY, KANSAS, ASSIGNOR TO THE KANSAS CITY GASOLINE COMPANY, OF KANSAS CITY, KANSAS, A CORPORATION OF KANSAS.

OIL-REFINING APPARATUS.

1,273,966. Specification of Letters Patent. Patented July 30, 1918.

Application filed July 22, 1916. Serial No. 110,794.

To all whom it may concern:

Be it known that I, FRANK E. WELLMAN, a citizen of the United States, residing at Kansas City, in the county of Wyandotte and State of Kansas, have invented certain new and useful Improvements in Oil-Refining Apparatus, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to the refining of mineral oils and has for its object the improvement of apparatus heretofore employed, in particulars to be hereinafter pointed out.

In prior applications, to which the present application is related, I have disclosed and claim apparatus and methods for cracking hydrocarbon oils either in the liquid phase or in the vapor phase, by separately controlled heat and pressure; and in certain of said applications I have described and claimed structural features, including welded coils, and expansion coils. For cracking in the vapor phase, the essential features thus disclosed are, a vaporizer or boiler working under atmospheric or approximately atmospheric pressure, a compressor deriving its supply from the vaporizer and designed to produce high pressures on its discharge side, a super-heater receiving the compressed vapors from the compressor, a fractionater or dephlegmator receiving the cracked product, a condenser, a receiving tank, and a return line with back trap, for carrying the uncracked heavier hydrocarbons back to the vaporizer for retreatment. Certain important ancillary features also appear in divers of my said prior applications, including an automatic back pressure valve or check valve between the compressor and super-heater, an automatic pressure relief valve between the check valve and the super-heater, a high pressure control valve between the super-heater and the condensing system, a precooler between the super-heater and said pressure controlling valve, a tell-tale for the return pipe or back trap, and observation means such as a glass column on the receiving tank, with controlling valves in the several pipe lines and connections.

An important improvement is described and claimed in my prior application S. No. 96,260, filed May 8, 1916, this improvement consisting not only in the coil structure as such, but in the application thereto of the principle of expansion, the super-heater coil being given a larger volume per unit length than the supply or feed pipe, whereby a number of important advantages are gained, including an increase in heating surface proportionately to the length, and an increase in the time element in the time of exposure, proportionate to the increase in volume, both being attained without interrupting the continuity of flow and without changing the continuous tubular character of the system of apparatus.

For cracking in the liquid phase, I have shown that the pump may be substituted for the compressor (using these terms in their specific trade sense), that the pressure in the super-heater can be produced or maintained in part autogenously, without losing the power of separate control of heat and pressure. I have also described and claim the adaptation of the foregoing apparatus and methods to liquid hydrocarbon phase cracking, and have attained a very high efficiency by the use thereof.

The present system, as will sufficiently appear hereinafter, combines my prior monophase systems, with the best results which I have so far attained. In actual commercial practice with this system I am able to produce approximately sixty-five per cent. total conversion from the crude oil into a mixed series testing out at approximately 60 degrees Baumé, or even higher, according to the nature of the crude employed. A great advantage moreover is presented, in the practical absence of coky or carbon deposits in the super-heater. This is partly due to the nature of the process itself, and partly to the fact that I pass from one step to another in the process, with constant intermediate eliminating of carbon, which would otherwise be deposited and would coke in the apparatus. To a certain extent this eliminating of carbon is accomplished step by step in my previous systems, which in the main employ the same process, but in the present case it is accomplished more perfectly, and I wish it understood that I consider it an important part of the invention, as well as in my said previous inventions and shall claim it accordingly.

Very briefly stated, the steps in the present process are as follows: (1) vaporizing the crude oil or mixed distillate at low pressure, approximately atmospheric pressure; causing the vapors to rise continuously

through a pipe line leading to a condenser system, the design of the pipe line being such that for any given temperature in the vaporizer, all hydrocarbons having boiling points below said temperature will pass over to the condenser, while those having boiling points of a range approximately or extending above said temperature, will condense and constantly drain back into the vaporizer; (2) gradually increasing the temperature in the vaporizer so as to force over all the hydrocarbons which will crack, and all those which will vaporize, at low pressure; (3) condensing the vapors and making a cut between the desired lighter series, whose boiling points are below say 350 degrees F., to which I may refer as gasolene, and those having higher boiling points to which I may refer as kerosene or heavy distillate; (4) receiving and storing the gasolene products; (5) receiving and pumping the heavy distillate or kerosene into my expansion coil super-heater and cracking the same therein under suitable heat and pressure; (6) carrying the mixed hydrocarbons after cracking through a large volume pipe, to and through a precooler; (7) carrying the cooled mixture through a pipe of reduced volume, (which permits the use of a controlling valve of relatively small size), and at increased linear speed, to fractional condensing means; (8) fractionating and taking off the lighter hydrocarbons or gasolene and condensing the same; (9) draining off the heavy constituents from the fractionater or dephlegmator to a back trap and return pipe line to the vaporizer or primary side of the system, for retreatment.

I shall hereinafter describe a specific arrangement of apparatus for practising the process thus briefly outlined, but it is of course to be understood that such description and the illustration accompanying it and forming a part of this application, are given for purposes of definition only, and not of limitation. Divers and sundry changes may be made in the apparatus and its connections, and even some changes in the process, as for example the temperatures employed, without departing from the spirit of my invention.

It will be observed without further description, that there are no less than three principal points in the progress of the oil through this system, at which the carbon and other objectionable constituents are partly combed out, viz; in the initial condensing vapor line, in the first cut and super-heater, and in the fractionater, or dephlegmator. In the last named I provide against undue rising of or clogging by the heavy constituents, so as to carry over only the gasolene product, and I take off each and all of the constituents having higher boiling points, to the back trap or return line.

My invention is illustrated in the accompanying drawings in which Figures 1 and 2, when placed together, contain a complete diagram in conventional form of the apparatus employed.

Referring to Fig. 1, 1 is a primary still or vaporizer with a suitable furnace which as shown is provided with both oil and gas jets, 2 and 3, for heating. These jets or nozzles have the usual controlling apparatus and the oil jet is supplied from any suitable source, while the gas jet is connected through a pipe 3^a to the receiving tank 4^a which in practice may be identical with tank 4^b but which in the drawing is shown separately for convenience of illustration. The still 1 is provided with the usual supply pipe and a drainage pipe 5 for drawing off the residual fuel oil and tar. It is normally closed by a tar plug 6 controlled as usual from without the still.

From the still 1 a vapor line service extends to the condenser 8, from which a discharge pipe 9 leads through a three way valve 10 to the receiving tank 4^b. A branch pipe 11 leads from the valve 10 to another receiving tank 12, from which extends a suction pipe 13 to the pump 14. From the pump a discharge pipe 15 is carried to the super-heater 16. In the pipe line 15 are connected an automatic check valve 17 and a normal relief valve 18. Up to this point the pipes employed are usually of one and one half inches internal diameter but the coil of the super-heater is expanded at the intake head 16^a to the internal diameter of approximately 5 inches. From the outlet head 16^b, an extension pipe 19, also of 5 inches internal diameter, is carried to the precooler 20 and extends through said precooler without any reduction in its diameter. The precooler may be of any desired form, but in practice I employ an iron tank in which water is caused to circulate, and which is conveniently made large enough to accommodate a number of coils of one and one half inch pipe 21 from the relief valve 18. This or an equivalent provision for cooling the relief pipe 21 is absolutely necessary in practice, in order to prevent the destructive effect of oil suddenly discharged into the atmosphere at high pressure and temperature. The valve 18 is a three way valve arranged to close the connection with pipe 15 and connect the coil 16 with the relief pipe 21 in emergency, but normally closing the relief passage and connecting the pipe 15 to the super-heater coil. The purpose of this is to prevent additional vapor being forced into the super-heater coil after a break occurs in the latter, which would otherwise add fuel in a dangerously heated condition, to any fire already started. For a similar purpose I insert a check valve 22 in the pipe 19 leading into the precooler

20. This check valve acts in case of emergency, to prevent the back flow of oil and vapor from the dephlegmator, to be later described, into the super-heater. In normal operation, the outflow of cracked products from the super-heater coil through the pipe 23 is regulated by the high pressure controlling valve 25.

The dephlegmator 24 is provided with a water jacket 26 with inlet pipe 27 and discharge pipes 28 and 29 set at different levels for the purpose of making a cut between products of different gravities. The dephlegmator is partly filled with divided material, such as metal shavings, offering a large surface and it has three discharge pipes 31, 32, and 33, the first emerging from the top, the second from the side, and the third from the bottom of the drum. The products which have a low enough specific gravity to pass over the top, are carried through the pipe 31 to a condenser 34, from which the condensed liquid and the fixed gases accompanying it are discharged into the receiving tank 4^a. These fixed gases are preferably used as fuel passing through the pipe 3^a to the nozzle.

The pipe 33, emerging from the bottom of the dephlegmator extends to the top of the tell-tale 35 provided with try cocks 36, or their equivalent, and having a bottom discharge pipe 37, connected through a three way valve 38 to the return pipe 39. The pipe 32, emerging from the side of the dephlegmator, is provided with gage 40 and is connected to valve 38 and pipe 39 through trap 41.

The operation of this apparatus is as follows:

The still or vaporizer 1 having been charged, is heated to a low boiling point at atmospheric pressure, for example 200 degrees. Vapor is formed and commences to go over through the pipe 7, at and below this temperature. As the heating continues, the vapor rises to the condenser 8, while any oil or heavy constituents carried up in divided form, or otherwise, drain back through the pipe 7 into the still 1. The length, size and amount of rise of the pipe 7 may vary somewhat, but to insure a successful cut between the natural or saturated gasolene series, and the heavier distillate there should be sufficient length and surface so that hydro-carbons vaporizing at or about the critical temperature will constantly condense and drain back into the pipe 7.

The heat in the primary still is gradually increased until a temperature is reached at which all the hydrocarbons of the gasolene series have gone over and been condensed, which may be ascertained by testing and observation of the product in the tank 4^b or by means of a drum with tell-tale insert in the pipe 9, or otherwise. As soon as the primary temperature has reached a point where the heavier material commences to go over, which requires cracking, the vlave 10 is manipulated to connect the pipe line through the branch 11 with a tank 12, and the connection to tank 4^b is shut off. The pump 14 is then started, and the super-heater coil 16 is partially filled with the heavier distillate or kerosene series, and heat is started in the furnace of the super-heater. With the high pressure controlling valve 25 closed, the temperature of the super-heater is raised, and at the same time the pump 14 is kept working to increase the pressure, until efficient cracking commences. The valve 25 is then manipulated so as to start an outflow of the cracked products through the pipe 23 to the dephlegmator, and thereafter the process is carried on continuously.

With a temperature of 700 degrees or over, and pressure at approximately 200 pounds, I find that from 12 to 15 per cent. conversion into the gasolene series is effected, while if the pressure is increased to approximately 800 pounds, this percentage rises to more than treble, or approximately 40 per cent. I have produced, at 200 pounds pressure, gasolene testing 61 degrees B., but pressure up to 800 pounds are preferable, with a temperature of 700 to 850 degrees F. on account of the increased quantity, and also of the better quality of the product, this being probably due to the more complete cracking.

As already stated the cracked product is taken through the pipe 23 into the dephlegmator, in which it rises and the lighter constituents pass over through the pipe 31 to the condenser coil 34 whence they discharge into the tank 4^a.

The uncracked and heavier constituents left in the dephlegmator are drained off through the pipe 33 and carried through the tell-tale drum 35 and valve 38 to the return pipe 39, by which they are conveyed back to the primary still to be mingled with the contents thereof, and again treated. The pipe 32, in addition to a fractionating function when it is desired to make a fine cut, serves to prevent choking up of the dephlegmator by the rise of heavier hydro-carbons therein, this being drained off through the pipe 32 as soon as they reach its level, and passing to the return pipe 39 through the trap 41. In this system, I provide valves of suitable type at all points where control is needed. For example, I insert a valve 3^b in the gas pipe 3^a at a point remote from the furnace, and I provide a similar valve at a remote point in the oil line leading to said furnace, so that the supply of fuel may be cut off therefrom without approaching the furnace if desired or necessary. At all other points, it is to be understood where high back pressure or a dangerous flow might occur, an easily operated valve is inserted. In addi-

tion to this, it will be noted that I have shown the relief valve 18 as provided with an operating lever instead of a hand wheel.

Having thus described my invention what I claim and desire to secure by Letters Patent is;

A system for treating liquid hydrocarbons comprising the following instrumentalities: a vaporizer or boiler, a vapor line leading to a point elevated above the vaporizer, a condenser connected to said vapor line, a discharge pipe for said condenser, means in said discharge pipe for effecting a cut between the hydrocarbons of different series in the condensed product, a pump connected with said means and adapted to receive the heavier hydrocarbons therefrom, a superheater coil connected to the pump, means for heating said coil, a dephlegmator or fractional separator receiving the hydrocarbons of mixed series from the superheater coil, after cracking therein, a condenser to condense said hydrocarbons having a low specific gravity, a receiving tank connected to said condenser, and a back trap or return pipe line connected to the dephlegmator, extending to the primary source of supply, and adapted to receive only the heavier uncracked hydrocarbons from the dephlegmator.

In testimony whereof I affix my signature.

FRANK E. WELLMAN.

3286

M. J. TRUMBLE.

PROCESS AND APPARATUS FOR CONVERTING PETROLEUM OILS.

APPLICATION FILED JULY 19, 1915.

1,281,884. Patented Oct. 15, 1918.

5 SHEETS—SHEET 1.

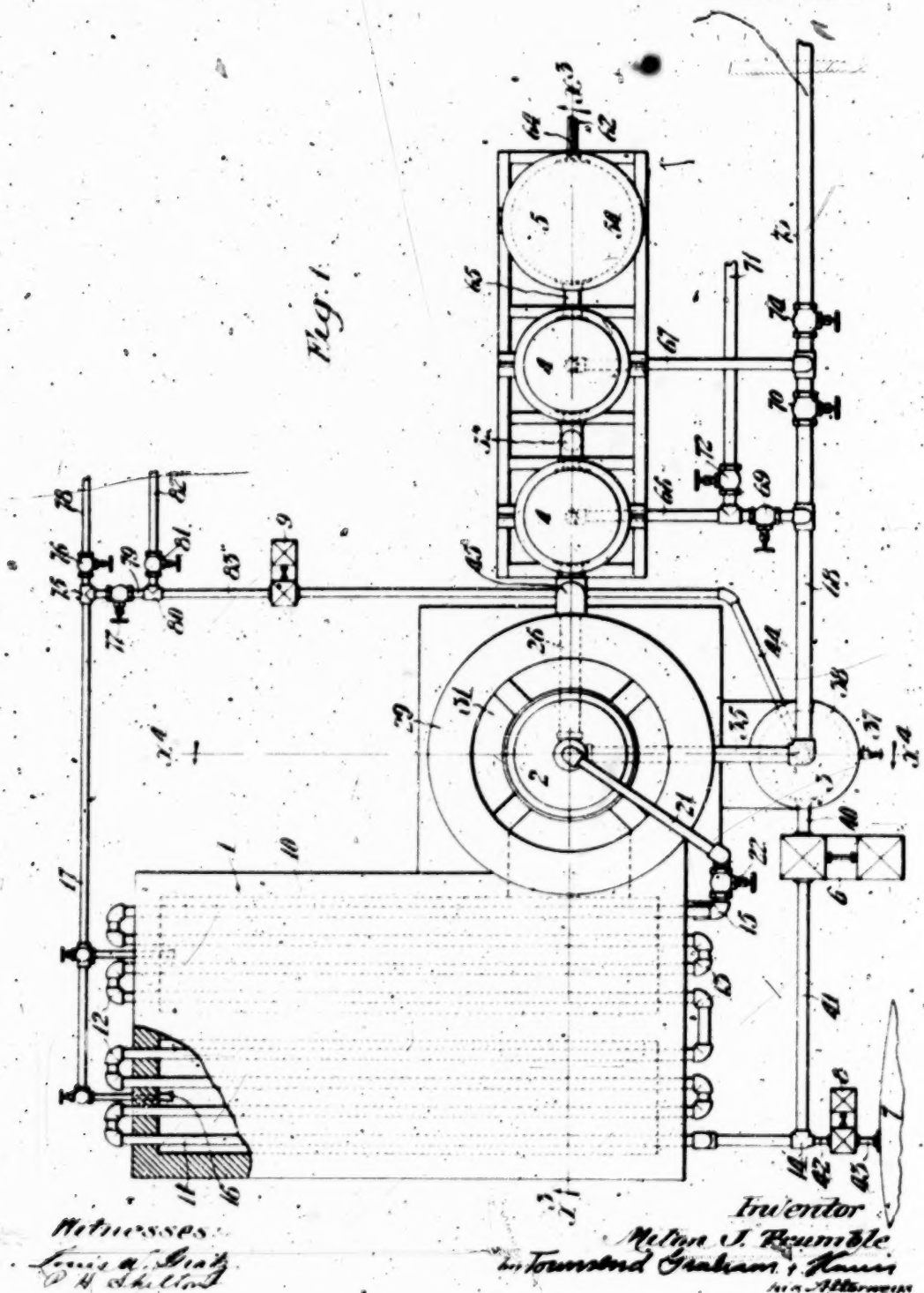


Fig. 1.

Witnesses:
Louis A. Pratt
C. H. Shelton

Inventor
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3288

M. J. TRUMBLE.

PROCESS AND APPARATUS FOR CONVERTING PETROLEUM OILS.

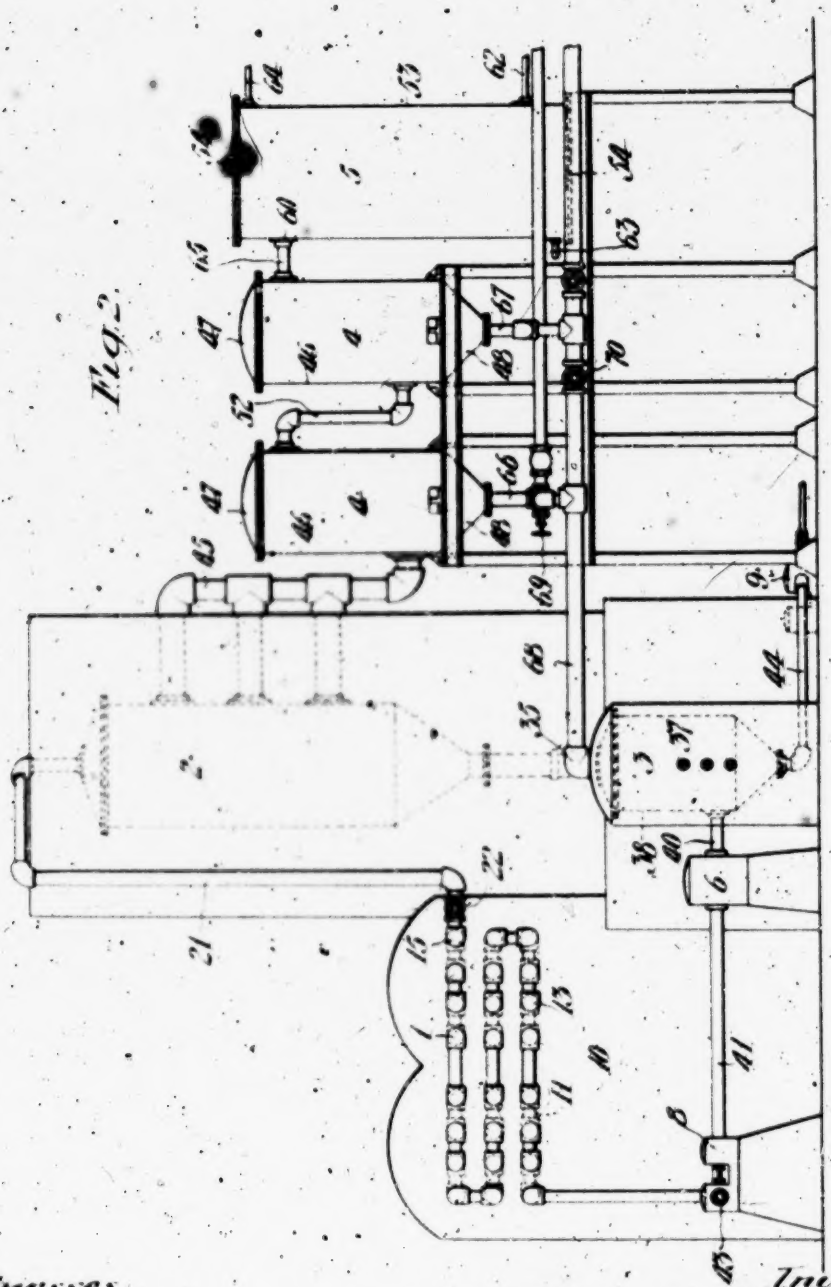
APPLICATION FILED JULY 19, 1915.

1,281,884.

Patented Oct. 15, 1918.

5 SHEETS—SHEET 2.

Fig. 2.



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3290

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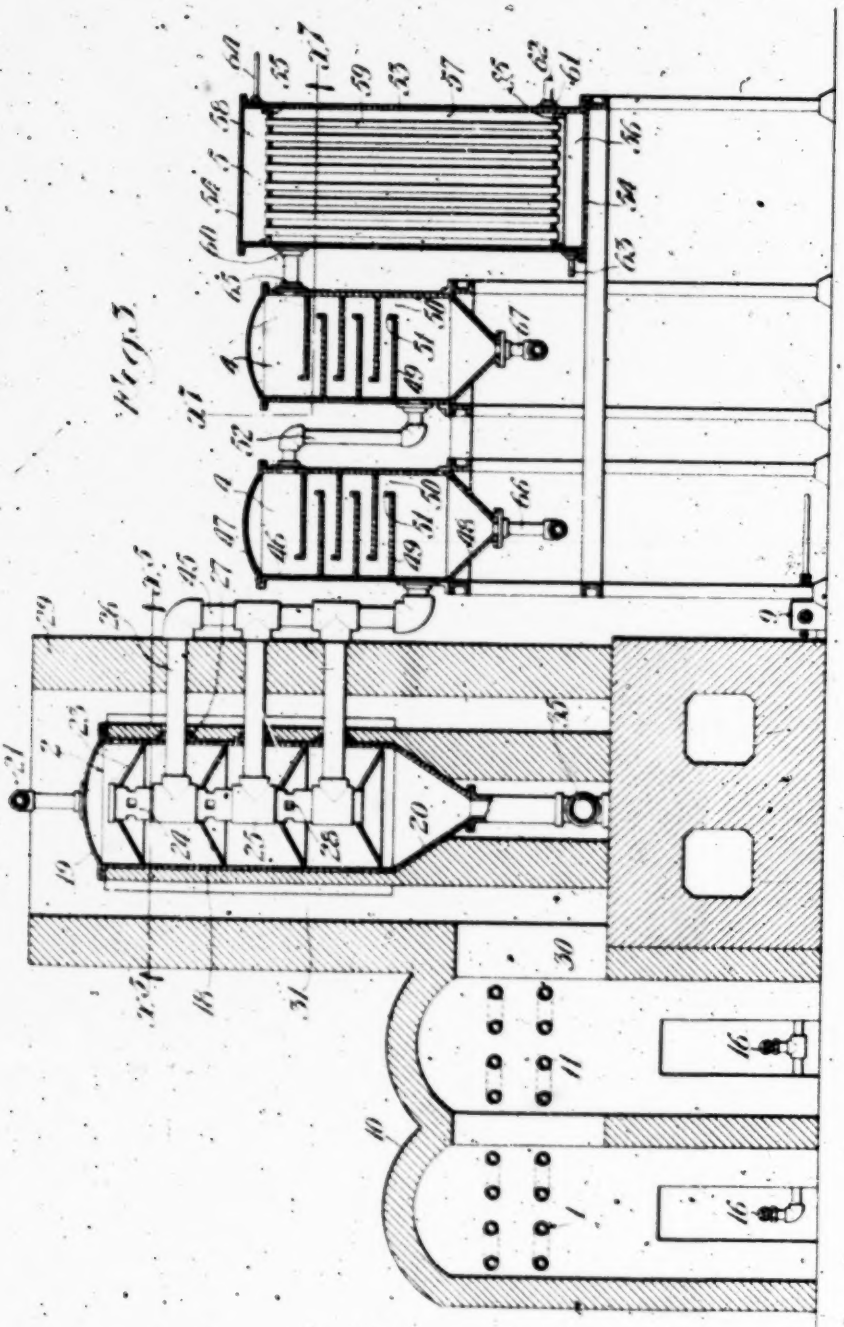
5 SHEETS—SHEET 3.



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3292

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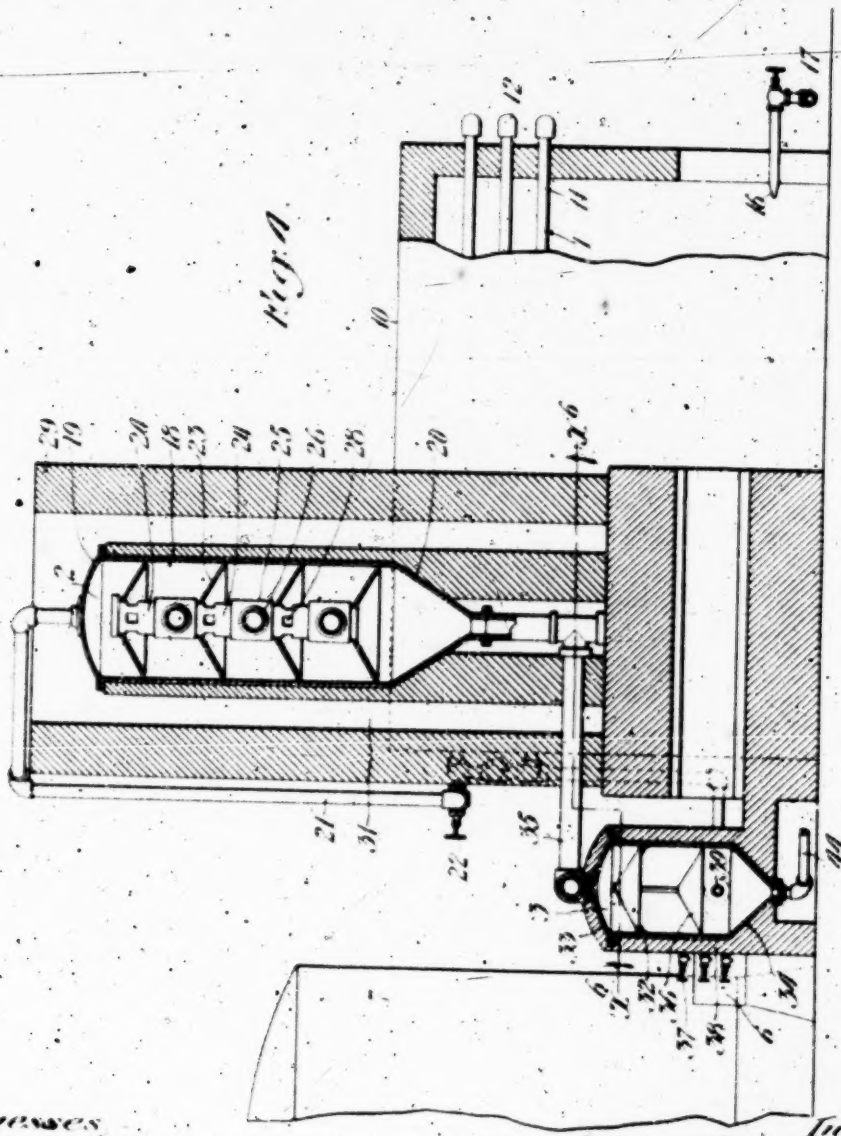
PROCESS AND APPARATUS FOR CONVERTING PETROLEUM OILS.

APPLICATION FILED JULY 19, 1913.

1,281,884.

Patented Oct. 15, 1918.

5 SHEETS—SHEET 4.



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3294

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PROCESS AND APPARATUS FOR CONVERTING PETROLEUM OILS.

APPLICATION FILED JULY 19, 1915.

1,281,884.

Patented Oct. 15, 1918.

5 SHEETS—SHEET 3.

Fig. 5.

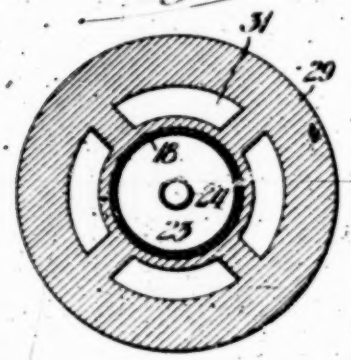


Fig. 6.

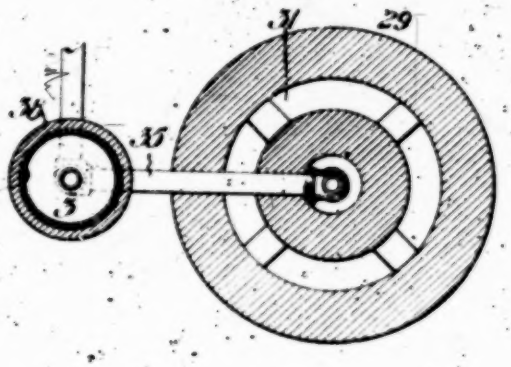


Fig. 7.

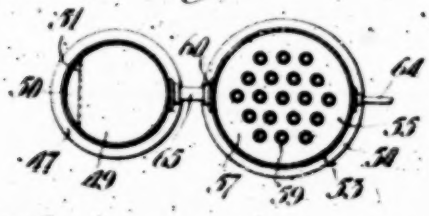


Fig. 8.

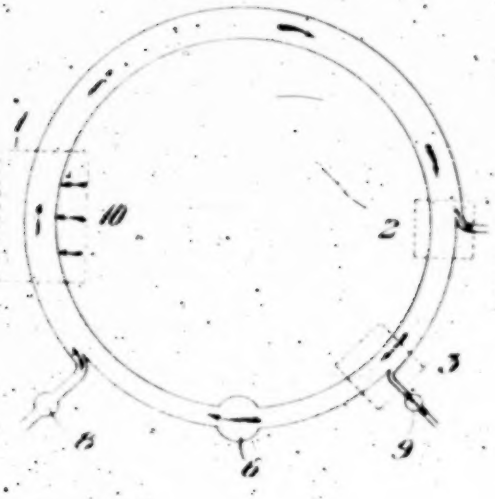
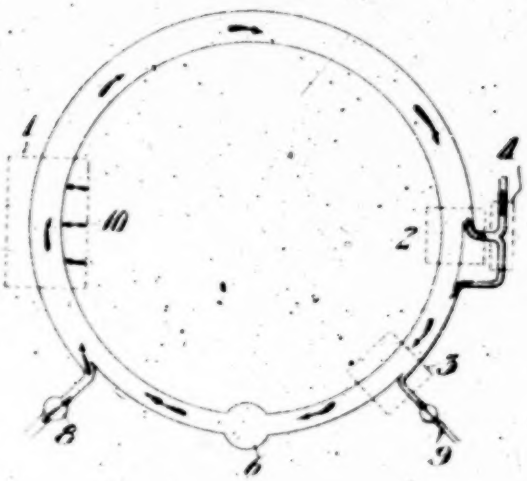


Fig. 9.



Witnesses:
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Inventor:
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his Attorneys

UNITED STATES PATENT OFFICE.

MILON J. TRUMBLE, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO SHELL COMPANY OF CALIFORNIA, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

PROCESS AND APPARATUS FOR CONVERTING PETROLEUM-OILS.

1,281,884. Specification of Letters Patent. Patented Oct. 15, 1918.

Original application filed July 19, 1915, Serial No. 40,794. Divided and this application filed July 19, 1915. Serial No. 40,795.

To all whom it may concern:

Be it known that I, MILON J. TRUMBLE, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles, State of California, have invented a new and useful Process and Apparatus for Converting Petroleum-Oils, of which the following is a specification.

This application is a division of an accompanying application for an apparatus for converting petroleum oils, serial No. 40,794, filed July 19, 1915.

The invention relates to the art of refining petroleum oils, and its principal object is to provide a process and apparatus by which petroleum oils of high specific gravity may be converted into oils of much lower specific gravity. There is at the present time a large production of oils of high specific gravity, hereinafter called heavy oils, and such oils are of much less commercial value than oils of low specific gravity hereinafter called light oils. The process and apparatus described herein has been used on a large scale to convert heavy oils into light oils.

The conversion of heavy oils into light oils has been previously accomplished in a crude way by various methods which are known in the art as "cracking" processes. Previous inventors have devised many forms of apparatus for cracking oils. This they have sought to accomplish by heat, with or without pressure, in some cases using various catalytic agents such as nickel, alumina, etc. The process described herein has the following advantages.

First, the process described herein is a continuous one, in which a definite volume of heavy oil is maintained in rapid motion at a cracking temperature through apparatus forming a closed ring, light oil vapors being removed as fast as formed, and fresh oil being continually supplied to take the place of the vapors withdrawn so that the volume of oil in the closed ring is maintained practically constant. In actual operation in large refineries the apparatus described has demonstrated that it can operate over a long period, continuously converting large quantities of heavy oils into light oils.

Second, it provides an apparatus in which the actual volume of heated oil is small, the large capacity of the apparatus being due to the high efficiency of the various parts. Where the ordinary form of cracking stills is used a large capacity can be economically obtained only by using large units, which, when running contain a large quantity of oil heated to such a temperature that it will spontaneously ignite when released into the air. A leak or break in such a still will result in the ejection of large volumes of highly heated oil which burns with great violence. This condition becomes more serious where the still is used under pressure. With the small volume of oil contained in the apparatus disclosed herein such serious conflagrations cannot occur. The apparatus therefore combines large capacity with great safety.

Third, the oil contained in the closed ring described above is forced through the heating means at a high velocity. The heating means comprises a series of pipes suitably connected to form a single continuous heating coil. The oil enters the coil at a moderate velocity and as it passes through the coil large quantities of vapor are gradually produced therein. This vapor remains intimately mixed with the body of the oil due to its rapid motion forming a foam which gradually increases in volume and consequently travels with an increasing velocity through the heating coil.

The high velocity of the oil in the closed ring produces several important results among which the following may be mentioned:

(*a*) This high velocity results in a high efficiency of heat transference, enabling large quantities of heat to be transferred to the oil from a relatively small heating surface.

(*b*) This high velocity results in a very uniform heating of the foamy mixture of oil and vapors so that there is no danger of producing undesirable products by local overheating.

(*c*) This high velocity prevents the deposition of carbon, or other solid or viscous materials on the interior of the heating coil so that the apparatus cannot become clogged or the efficiency of the heating surface destroyed by such deposition.

(*d*) This high velocity prevents unequal

heating of the heating coil as all parts of the coil are uniformly cooled by the oil flowing therethrough. The uniform and moderate heating of the coil gives the apparatus a long life and results in great safety of operation.

Fourth, the apparatus disclosed herein is especially adapted to work under pressure. It is a well known fact that the character of the products obtained from petroleum oils by cracking is not only dependent on the temperature but also to a very great degree on the pressure under which the cracking takes place. The heating coil being composed of pipes is well adapted to stand high pressures even when heated, and these pressures are readily controlled by an adjustable valve through which the heating coil discharges.

Fifth, the apparatus is especially adapted to maintain constant the conditions under which the oil circulates through the closed ring, and to maintain constant the composition of the oil and the percentage of solid matter carried therein. Solid substances may be contained in the oil introduced into the apparatus, and solid hydrocarbons or even free carbon may be formed in the apparatus. Such solid substances cannot be vaporized and it is important that the circulating oil be relieved of them at the same rate at which they are formed if the composition of the oil is to be maintained constant. This condition of equilibrium is maintained in the closed ring by a constant withdrawal of light vapors, a constant withdrawal of heavy oil and included solids, and a constant replacement of the volume so withdrawn by fresh oil. The heavy oil can be conveniently withdrawn from the bottom of the settling tank forming a portion of the closed ring.

In practice a very small flow of heavy oil through the relief pipe is sufficient to prevent undue accumulations of objectionable solids in the body of the circulating oil. For example with California oils on which the apparatus has been commercially operated the amount of oil withdrawn through the relief pipe is less than five per cent. of the oil introduced through the makeup pump.

The apparatus described herein differs greatly in method of operation and results from the ordinary forms of cracking stills. In such stills a constant character of product cannot be obtained as the condition of the oil in the still and consequently the character of the product obtained changes gradually as the process proceeds.

In the apparatus described herein the oil circulating in the closed ring is maintained under constant conditions of temperature, pressure, and composition, so that the character of the product obtained is constant. However, the temperature, pressure and composition of the oil in the closed ring may each or all be varied so that the character of the product obtained can be varied within certain practical limits.

Sixth, the apparatus described herein is provided with means for fractionating the vapors taken off and for returning certain undesirable constituents thereof to the ring for retreatment. This is important as it may be undesirable, or even impossible, in the practical operation of the apparatus to regulate the conditions in the closed ring to such a degree that only the desired product is produced. It is especially easy to operate various forms of fractionating apparatus with the apparatus disclosed herein as the character of the vapors given off, and the rate of flow thereof, is constant. The fractionating apparatus can therefore be operated under certain constant conditions with a consequent large capacity and high efficiency.

In the drawings which are for illustrative purposes only:

Figure 1 is a plan view showing a certain arrangement of apparatus which is adapted to carry on the process.

Fig. 2 is an elevation of said apparatus.

Fig. 3 is a section on a plane represented by the line x^3—x^3 in Fig. 1 looking in the direction of the arrows.

Fig. 4 is a section on a plane represented by the line x^4—x^4 in Fig. 1 looking in the direction of the arrows.

Fig. 5 is a section on the plane represented by the line x^5—x^5 in Fig. 3 looking in the direction of the arrows.

Fig. 6 is a section on the plane represented by the line x^6—x^6 in Fig. 4 looking in the direction of the arrows.

Fig. 7 is a section on the plane represented by the line x^7—x^7 in Fig. 3 looking in the direction of the arrows.

Fig. 8 shows a schematic diagram illustrating the process in a simple form.

Fig. 9 shows a similar diagram illustrating a modification of the process.

In the following description the term crude oil is used to designate the oil to be treated. This may be a natural oil in its raw state or it may be the product of previous refining or other treatment.

The apparatus illustrated by the drawings consists of a heating coil 1, a vapor releaser 2, a settling tank 3, dephlegmators 4, and a condenser 5. A circulating pump 6 delivers oil from the settling tank 3 to the coil 1, crude oil is delivered to the coil 1 from a tank 7 by a make-up pump 8, and heavy oil with its included solids is drawn from the settling tank 3 by a relief pump 9.

The heating coil 1 is placed in a furnace 10 and consists of a series of pipes 11 joined into a continuous coil by pipe fittings 12 and 13. An inlet T 14 and an outlet elbow 15

are secured on either end of the coil 1. Oil burners 16 of any well known form extend into the furnace 10, being fed with fuel from a fuel supply pipe 17.

The vapor releaser 2 may be of any suitable form. The form shown consists of a shell 18 having secured thereto a top 19 and a conical bottom 20. A hot mixture pipe 21 discharges through the top 19 being connected to a pressure control valve 22 which is connected to the elbow 15. Deflecting cones 23 are secured on pipe members 24 which are connected by T's 25 to vapor outlet pipes 26. The vapor outlet pipes 26 pass through the shell 18, a tight joint therewith being insured by flanges 27. The cones 23 are of such a diameter that a small annular space is left between their outer edge and the inner wall of the shell 18. The pipe members 24 have perforations 28 cut therein. The vapor releaser may be heat insulated by proper covering material, or preferably it may be supported in a stack 29, as shown, being partially heat insulated by the use of a fire brick wall which surrounds it. An opening 30 connects the lower part of the stack with the interior of the furnace 10. An annular space 31 allows hot gases to ascend between the vapor releaser 2 and the wall of the stack.

The settling tank 3 illustrated consists of a shell 32 having a tight top 33 and a conical bottom 34. A residuum outlet pipe 35 connects the bottom 20 of the releaser 2 with the top 33 of the settling tank 3. A series of perforated deflecting and mixing cones 36 may be located in the settling tank 3 if desired. Pet cocks 37 allow the height of liquid in the settling tank to be readily determined. The settling tank may have heat insulation 38 applied thereto. If desired the settling tank 3 may be dispensed with, the bottom of the vapor releaser 2 being utilized as a settling tank. For clearness in description the settling tank is shown as a separate piece of apparatus.

An outlet opening 39 is provided in the side of the tank 3, a pipe 40 connecting this outlet with the circulating pump 6. A pipe 41 connects the pump 6 with the inlet T 14 to which is also connected the crude oil inlet pipe 42 which is fed from the tank 7 through a pipe 43 and the make-up pump 8. A relief pipe 44 connects the relief pump 9 to the conical bottom 34 of the settling tank 3.

A vapor column 45 connects the vapor outlet pipes 26 to the lower portion of one of the dephlegmators 4. These may be of any of the well known forms, those illustrated consisting of a shell 46 having a tight cover 47 and a conical bottom 48. A series of condensation plates 49 extend across the interior of the shell 46 having openings 50 formed therein, the openings 50 having a raised lip 51 so that condensates can collect on top of each plate 49, the openings 50 in the different plates being staggered with relation to each other. The top portion of the first dephlegmator is connected to the bottom of the second dephlegmator by a pipe 52.

Any form of condenser 5 may be used. That illustrated consists of a shell 53 having tight ends 54 and inner heads 55 which divide the interior of the shell into a water inlet space 56, an oil space 57 and a water outlet space 58. Tubes 59 are tightly secured in the heads 55 connecting the spaces 56 and 58 and extending through the space 57. A vapor inlet fitting 60 opens into the top of the space 57 and a distillate outlet fitting 61 delivers light distillate to a pipe 62 from the bottom of that space. Water is supplied to the spaces 56 and 58 and to the interior of the tubes 59 by a water inlet pipe 63, this water being discharged through a water outlet pipe 64. The top portion of the last dephlegmator 4 is connected to the vapor inlet fitting 60 through a pipe 65. A distillate discharge pipe 66 connects to the lower end of the conical bottom 48 of the first dephlegmator 4, and a similar pipe 67 is similarly connected to the second dephlegmator 4. The pipe 67 may be connected with a distillate return pipe 68 through a valve 69, and pipe 67 may also be connected to the pipe 68 through a valve 70. The pipe 66 may also be connected to a heavy distillate discharge pipe 71 through a valve 72, and the pipe 67 may be connected to a heavy distillate discharge pipe 73 through a valve 74. The fuel supply pipe 17 connects into a T 75 to which are connected valves 76 and 77. A fuel pipe 78 connects into the valve 76 and a pipe 79 connects the valve 77 with a T 80 into which is connected a valve 81, this valve being connected to a heavy oil discharge pipe 82. The T 80 is connected to the pump 9 through a pipe 83.

The method of operation of the apparatus is as follows:

Crude oil is pumped to the inlet T 14 through the pipe 42 by the make-up pump 8, this oil being drawn through the pipe 43 from the tank 7. Oil from the inlet T 14 flows through the pipes 11 and the fittings 12 and 13 to the outlet elbow 15 and through the valve 22 to the pipe 21. It is discharged from the pipe 21 into the vapor releaser 2 flowing downwardly therethrough and through the pipe 35 into the settling tank 3. As soon as sufficient oil collects in the settling tank 3, which can be ascertained by the pet cocks 37, the circulating pump 6 is started and the oil is forced around the closed ring of apparatus consisting of the pipe 41, the pipes 11, fittings 12 and 13, the pipe 21, the vapor releaser 2, the pipe 35, the settling tank 3, the pipe 40, and the pump 1

6. The burners 16 are then lighted, oil being supplied from the pipe 17. It is necessary to fill the various parts of the closed ring with oil and to put this oil into rapid motion before the burners are lighted as there would otherwise be danger of too rapidly vaporizing the oil in the pipes 12. The pipe 17 may be supplied with fuel through the pipe 78, the valve 76 being open and the valve 77 being closed, or the valves 76 and 81 may be closed and the valve 77 opened, in which case oil is fed into the pipe 17 through the valve 77 from the pipe 83, this oil being taken off from the settling tank 3 through the pipe 44 and the pump 9. When the oil taken off from the settling tank through the pipe 44 is not used for fuel purposes, the valve 77 may be closed and the valve 81 opened, in which case the oil is delivered to suitable tankage not shown through the pipe 82. The flame and hot gases of the burners 16 play against the pipes 11 of the heating coil 1 and escape through the opening 30 into the stack 29 where they ascend through the annular space 31 between the shell 18 and the inner wall of the stack. The oil in the closed ring is rapidly heated, and as it enters the vapor releaser 2 is spread in a thin film over the inner walls of the shell 18 by the cones 23, vapors escaping from the film passing through the openings 28 into the pipes 24 and through the vapor outlet pipes into the vapor column 45. The further course of the vapors will be set forth hereinafter.

As the oil circulates through the closed ring of apparatus above defined, vapors are continually removed by the vapor releaser and sufficient crude oil is constantly injected by the make-up pump 8 to maintain a constant volume of oil in the apparatus. The entering crude oil may contain carbon, solid hydrocarbons, sand, silt or other foreign matter. It may also contain liquids that will not be vaporized or cracked at the operating temperature of the apparatus. All of these substances as well as any similar substances formed in the oil in its circulation through the closed ring must therefore remain in the oil after it has passed through the vapor releaser 2, and unless some means were provided to dispose of them, must eventually choke the closed ring or at least render the oil in it of such a character that little evaporation or cracking could take place therefrom.

To relieve this condition, a small quantity of oil is constantly withdrawn from the extreme bottom of the settling tank 3, this material being conveniently disposed of by feeding it by means of the pump 9 and the pipe 17 to the burners 16 where it is readily burned. The oil being somewhat reduced in velocity in passing through the settling tank, any material that will settle anywhere in the closed ring will settle to the bottom of the tank. It is not, however, necessary to provide such a settling tank, as the heavy oil may be removed from the bottom of the vapor releaser or indeed anywhere between the vapor releaser and the inlet to the heating coil.

The oil enters the heating coil 1 at a moderate velocity and is practically free from vapor. As it circulates through the heating coil a portion thereof is broken up to form a lighter hydrocarbon, the small globules of light vapor being swept on by the moving mass of oil which assumes a foamy nature. This foam greatly increases the volume of the flowing stream which therefore accelerates rapidly. The movement of the oil and vapor through the heating coils is sufficiently rapid to provide high efficiency of heat transfer between the interior of the pipes 11 and the oil, to uniformly heat the oil and vapors, so that none of it is subjected to excessive temperatures, to prevent any deposits of solid or viscous material on the interior of the pipes 11, and to prevent local overheating anywhere in the coil 1, so that the coil has a long life and is very safe to operate. The foam remains in the heating coil 1 only a very short time, being immediately passed into the vapor releaser 2 where the vapors are withdrawn from the oil. This is important as there is some danger of the vapors being further cracked if retained in the heating coil.

When operating with some sorts of crude oil, it is necessary to put some pressure on the oil in the heating coil 1 to produce a desired product. This can be readily done by partially closing the valve 22.

In practical operation, the heat of the fire, the rate of injection of crude oil, the speed of the circulating pump, the rate of withdrawal through the relief pipe 44, and the pressure are all regulated so that the oil passing through the closed ring is subjected to a definite and constantly recurring cycle of conditions. It is of course obvious that there are limits within which the various factors can be practically controlled and there are therefore practical limitations to the product that can be obtained by this process from a given oil. The product can, however, be very materially modified by a suitable modification of the conditions in the closed ring, and one great advantage of the present process is the ease with which conditions in the ring can be modified to produce the best commercial results.

The vapors in the vapor column 45 may be the desired product, in which case the dephlegmators 4 can be dispensed with, the vapors being passed directly into the condenser 5, condensed therein and passed off through the pipe 62. It may be desired to

separate the product into distillates of several gravities, in which case the dephlegmators are very convenient.

The vapor passes from the vapor column 45 to the bottom of the first dephlegmator and through a tortuous course through the openings 50 to the top. The vapors then pass through the pipe 52 to the second dephlegmator and through the openings 50 to the top thereof. The vapors in passing through the dephlegmators are gradually cooled, a heavy distillate collecting on the plates 49 and running over the lips 51 into the bottom of the first dephlegmator. A medium distillate condenses and collects in the second dephlegmator. The vapors not condensed in the dephlegmators are condensed in the condenser 5 to form a light distillate which is delivered through the pipe 62. The heavy distillate may be a desirable commercial product in which case the valve 69 is closed and the valve 72 is opened, the heavy distillate being delivered through the pipe 71 after cooling to suitable tankage. If the heavy distillate is not a desirable commercial product, the valve 72 may be closed and the valve 69 opened, the heavy distillate being delivered to the pipe 68. If the medium distillate delivered by the pipe 67 is a desirable commercial product the valve 70 is closed and the valve 74 is opened, the medium distillate being delivered after cooling to suitable tankage through the pipe 71. If this medium distillate is not a desirable commercial product by opening the valve 70 and closing the valve 74, medium distillate can be delivered to the pipe 68. Any distillate delivered to the pipe 68 is returned to the settling tank 3, being delivered onto the mixing plates 36 where it mixes with oil delivered from the vapor releaser 2 through the pipe 35, thereby being reintroduced into the closed ring for retreatment.

It will be seen that the invention consists of the following original conceptions:

First, the forcing of petroleum oils through a heating coil, heated to a sufficient degree to crack the oil, at such a rate and at such a pressure that the oil can be changed into a foam without danger of unduly heating portions thereof or burning the coil, it having been found by the inventor that heavy petroleum oils are changed to light ones by such a process.

Second, the immediate release of the foam so produced, the removal of vapors therefrom and the immediate recirculation and reheating of the oil to form more foam, the oil being kept in continuous motion over a closed ring or path.

Third, the condensation of a portion of the vapors so produced, and the return to the closed ring of the heavy distillate so produced.

Fourth, the use of the settling tank 3 in a closed ring and the continuous removal of heavy oil and foreign matter from the bottom of this tank, so that accumulations of solid matter in the ring is prevented and the composition of the oil in the closed ring is maintained constant.

Fifth, the use of the make-up pump 8 for the purpose of maintaining constant the volume of the closed ring as vapors and heavy oil with included sediments are taken off therefrom.

Sixth, the use as fuel in the burners 16 of the hot heavy oil from the bottom of the tank 3.

I claim as my invention:

1. The process of converting a heavy petroleum oil into a light one which consists in circulating the heavy oil through a closed ring, continuously heating a portion of the ring, continuously taking off light vapors from the ring, continuously relieving the ring of a small amount of heavy oil, and continuously supplying fresh oil in sufficient quantities to maintain constant the volume of oil in the closed ring.

2. The process of converting a heavy petroleum oil into a light one which consists in circulating the heavy oil through a closed ring, continuously heating a portion of the ring, maintaining a pressure on the portion of the ring so heated, continuously taking off light vapors from the ring, continuously relieving the ring of a small amount of heavy oil, and continuously supplying fresh oil in sufficient quantities to maintain constant the volume of oil in the closed ring.

3. The process of converting a heavy petroleum oil into a light petroleum oil which comprises, first, forcing the heavy oil through a heating coil, said coil being heated to a sufficient degree to crack the oil, said heavy oil being forced through said coil at such a rate and at such a pressure that the oil is changed into foam without danger of unduly burning portions thereof, second, removing light vapors from the stream of oil, third, recirculating the residuum left after said vapors are removed through said heating coil to form more foam, said oil thus being kept in continuous movement over a closed path or ring, fourth, condensing a portion of the vapors so removed, the distillates so condensed being returned to the closed ring for retreatment, fifth, constantly removing a small portion of the heavy oil and included solids from the ring, and simultaneously with the above steps supplying crude oil to said ring to replace any diminution in volume of the oil therein, so that the volume of oil in said ring is maintained constant.

4. An apparatus for converting heavy petroleum mixtures into light petroleum oils, comprising a heating means; a vapor releaser; means for conducting the heated mix-

ture from the primary heating means to the vapor releaser; means for withdrawing light vapors from the vapor releaser; means for continuously withdrawing a portion of the mixture; means for forcing the residuum from the vapor releaser through the primary heating means; and means for injecting sufficient fresh heavy oil into said residuum to maintain the volume of oil in the apparatus approximately constant.

5. An apparatus for treating liquids comprising a furnace; a burner for said furnace; a heating coil in said furnace; a vapor releaser; pipes connecting said heating coil with said releaser; a series of dephlegmators; pipes conducting the vapors from said vapor releaser successively through said dephlegmators; a condenser; a circulating pump; pipes delivering the residuum from said vapor releaser to the suction side of said pump; a make up pump; a crude oil supply pipe delivering crude oil to the suction side of said make up pump; pipes connecting the pressure side of said make up pump and said circulating pump with the inlet to said heating coil; and a relief pipe through which a portion of the residuum from said vapor releaser can be withdrawn from the system.

6. An apparatus as in claim 5 also comprising a settling tank through which the residuum from said vapor releaser passes on its way to said circulating pump, said relief pipe being connected into said settling tank.

7. An apparatus for treating liquids comprising a furnace; a burner for said furnace; a heating coil in said furnace; a vapor releaser; pipes connecting said heating coil with said releaser; a circulating pump; pipes delivering the residuum from said vapor releaser to the suction side of said pump; a make up pump; a crude oil supply pipe delivering crude oil to the suction side of said make up pump; pipes connecting the pressure side of said make up pump and said circulating pump with the inlet to said heating coil; and a relief pipe through which a portion of the residuum from said vapor releaser can be withdrawn from the system.

8. An apparatus as in claim 7 also comprising a settling tank through which the residuum from said vapor releaser passes on its way to said circulating pump; said relief pipe being connected into said settling tank.

In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 10th day of July, 1915.

MILON J. TRUMBLE.

3302

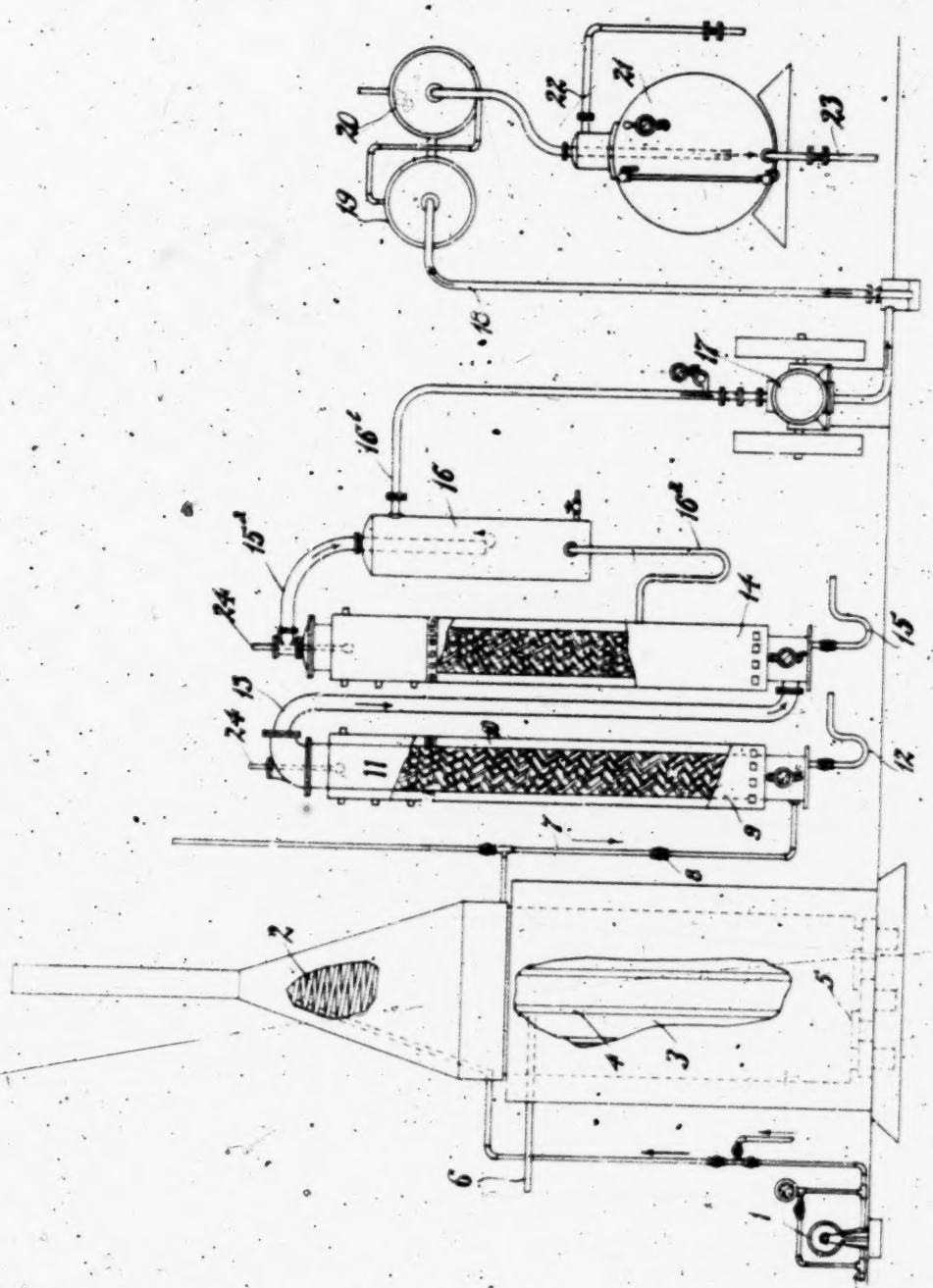
W. A. HALL.

APPARATUS FOR MAKING MOTOR FUEL.

APPLICATION FILED FEB. 9, 1916.

1,285,136.

Patented Nov. 19, 1918.



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UNITED STATES PATENT OFFICE.

WILLIAM AUGUSTUS HALL, OF NEW YORK, N. Y.

APPARATUS FOR MAKING MOTOR-FUEL.

1,285,136. Specification of Letters Patent. Patented Nov. 19, 1918.

Original application filed January 23, 1915, Serial No. 3,955. Divided and this application filed February 9, 1916. Serial No. 77,357.

To all whom it may concern:

Be it known that I, WILLIAM A. HALL, a citizen of the United States, residing at New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Apparatus for Making Motor-Fuel, of which the following is a specification.

This invention relates to an apparatus for the production of a motor fuel suitable for use in automobile engines by the process described in my copending application Serial No. 3955, filed January 23, 1915, of which the present case is a division, and which has now matured into U. S. Patent No. 1,175,910.

An example of an apparatus embraced within the scope of the present invention is shown in elevation (partly in section) in the accompanying drawing which forms a part of this specification.

In said drawing 1 shows a pump for introducing the oil under considerable pressure through the superheating coil 2, which may be heated by waste heat arising from the furnace 3, and which pipe coil 2 is connected in series with a coil of vertical piping 4, which may be of a diameter of 1 or 1¼ inch pipe (although the diameter of this pipe is not essential), which pipes are heated by means of suitable burners 5, to any desired temperature, for example 540 to 600° C., more or less. The length of the pipe comprising the coil 4 is preferably about 320 feet, although this may be longer if desired. At 6 I show a pyrometer placed between the coils of the pipes 4, for measuring the temperature.

Connected to the outlet end of the piping 4 is a pipe 7, preferably having therein a throttle valve 8, which leads to the lower part of a first preliminary condenser 9, which may be filled with checkerwork, for example composed of pieces of pipe or other shapes, as shown at 11, and the condenser 9 may be surrounded by a cooling jacket 10. At 12 is shown a pipe for drawing off any material condensed in the condenser 9.

The pipe 13 leads the gases and vapors from the upper end of the condenser 9, to a second preliminary condenser 14, which may be similar in construction to the condenser 9. From the bottom of this condenser a pipe 15 serves to carry off any liquid condensed therein, for further use. From the upper portion of the condenser 14, a pipe 15^a leads to a trap 16, in which a portion of the mist carried by the gases and vapors may separate out, and be withdrawn through the pipe 16^a into the condenser 14. From the upper portion of the trap 16, a pipe 16^b carries the gases and vapors to the inlet side of a suitable compressor 17, in which the gases and vapors are condensed to a suitable pressure, after which they pass while under pressure through the pipe 18, condenser 19 and 20, the condensate collecting in tank 21, the uncondensed gases being drawn off by pipe 22; and the motor fuel being drawn off through pipe 23, for any desired subsequent purification.

24 illustrates thermometers placed in the upper ends of the towers 9 and 14, for showing the temperature of the gases and vapors leaving these towers.

The present application is also in part a continuation of my copending application 824,194, filed March 12, 1914, and 829634 filed April 4, 1914.

It will be noted that the valve 8 acts as a pressure-reducing valve, that is to say this valve is preferably set so as to maintain a higher pressure in the coil 2 and the retort 4, than is maintained in the preliminary condenser 9. Thus, without limiting myself to the particular pressures described in my prior cases above referred to, I may employ a pressure of 60 to 90 lbs. per square inch in the decomposing coil, about atmospheric pressure in the preliminary condensers, and then may raise the pressure by the compressor to 75 or 100 or 125 lbs.

While I have shown the two condensers or towers 9 and 14, as forming the two parts of a preliminary condenser, I call attention to the fact that any suitable structure of preliminary condenser may be employed, and I do not limit myself to the use of a preliminary condenser comprising two towers.

What I claim is:—

1. In an apparatus for converting oils of higher boiling points into oils of lower boiling points, the combination of a decomposing retort comprising a series of vertical loops, means for maintaining a pressure of several atmospheres therein, means for forcing oil into said retort, against such pressure; a preliminary condenser, means for passing the gases and vapors from said re-

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tort to and through said preliminary condenser, means for compressing the gases and vapors leaving the said preliminary condenser, means for further cooling the compressed gases and vapors, and means for maintaining in the decomposing retort, a pressure materially above that in the preliminary condenser.

2. An apparatus comprising a pressure pump, a tubular decomposing retort adapted to contain fluids under several atmospheres pressure, a preliminary condenser, a compressor and a second condenser, all arranged in series, in the order stated, and connections therebetween, and means for maintaining in the decomposing retort, a pressure materially above that in the preliminary condenser.

3. An apparatus comprising a tubular decomposing retort adapted to contain fluids under a pressure of several atmospheres, a filled preliminary condenser, a compressor and a second condenser, all arranged in series in the order stated, and connections therebetween, the connection between the said decomposing retort and said preliminary condenser being provided with a pressure-reducing valve.

4. A pressure-producing device, a tubular decomposing retort adapted to be continuously operated under a pressure of several atmospheres, a preliminary condenser, a compressor and a second condenser, all arranged in series in the order stated and connections therebetween, and means in the connection between the retort and the preliminary condenser for controlling the amount of gases and vapors allowed to pass through such connection, and for maintaining a higher pressure in the decomposing retort than in the preliminary condenser.

5. A pump, a preheating coil, a tubular retort, a pressure-reducing valve, a preliminary condenser, a compressor, and a second condenser adapted to be operated under pressure, all arranged in series in the order stated.

6. A pressure-maintaining device, a decomposing retort adapted to be operated under a pressure of several atmospheres, a preliminary condenser capable of being operated at a pressure below that used in said retort, a compressor and a condenser having cooling means, arranged in series in the order stated, and fluid-tight connections therebetween.

7. In an apparatus for converting oils of higher boiling points into oils of lower boiling points, the combination of a tubular decomposing retort capable of being operated under a pressure of several atmospheres, a pump for pumping oil into said retort, against superatmospheric pressure therein; a preliminary condenser, means for maintaining in said retort, a pressure materially above the pressure in said condenser, means for passing the gases and vapors from said retort to and through said preliminary condenser, means for compressing the gases and vapors leaving the said preliminary condenser, and means for further cooling the said gases and vapors.

In testimony whereof I affix my signature.

WILLIAM AUGUSTUS HALL.

3306

L. O. SHERMAN.

METHOD OF AND APPARATUS FOR DISTILLING PETROLEUM AND THE LIKE.

APPLICATION FILED NOV. 15, 1917.

1,288,711.

Patented Dec. 24, 1918.

3 SHEETS—SHEET 1.

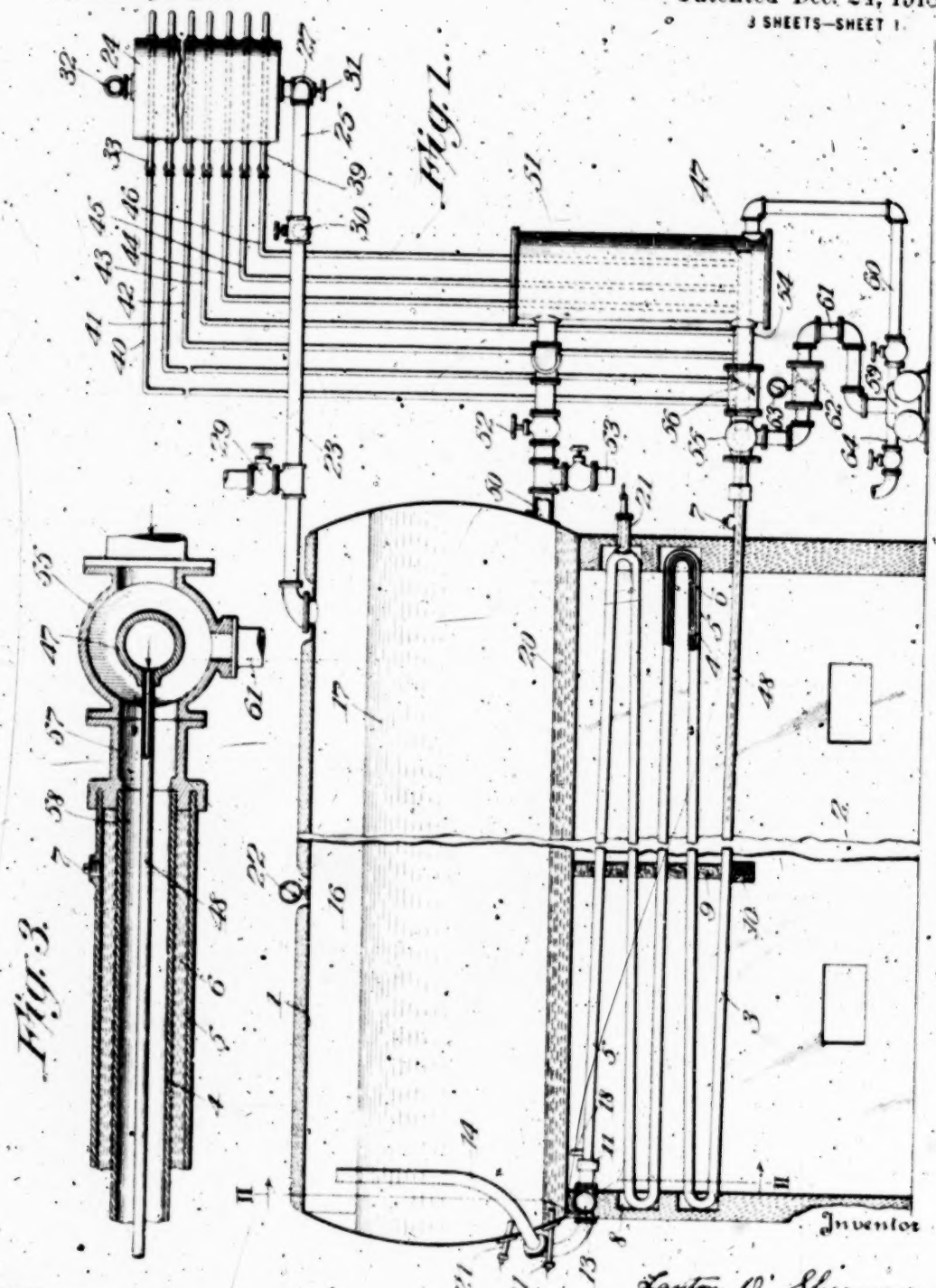

FIG. 1.

FIG. 3.

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APPLICATION FILED NOV. 15, 1917.

1,288,711. Patented Dec. 24, 1918.

3 SHEETS—SHEET 2.

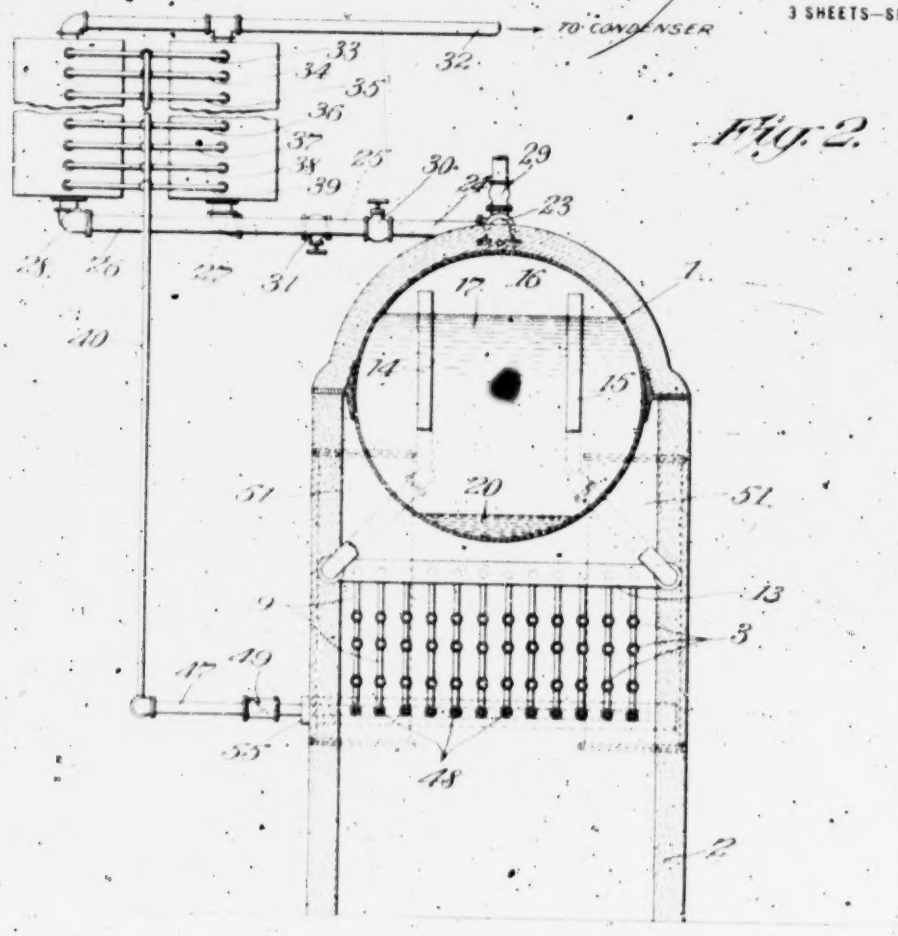

Fig. 2.

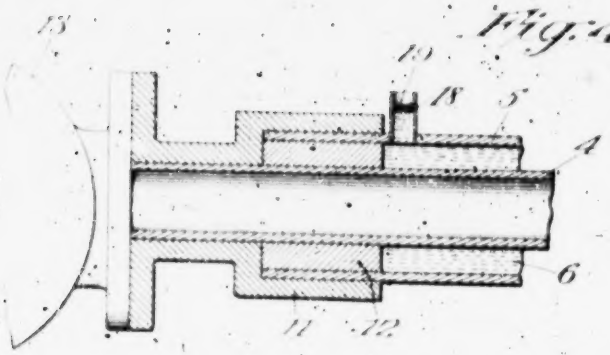

Fig. 4.

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METHOD OF AND APPARATUS FOR DISTILLING PETROLEUM AND THE LIKE.

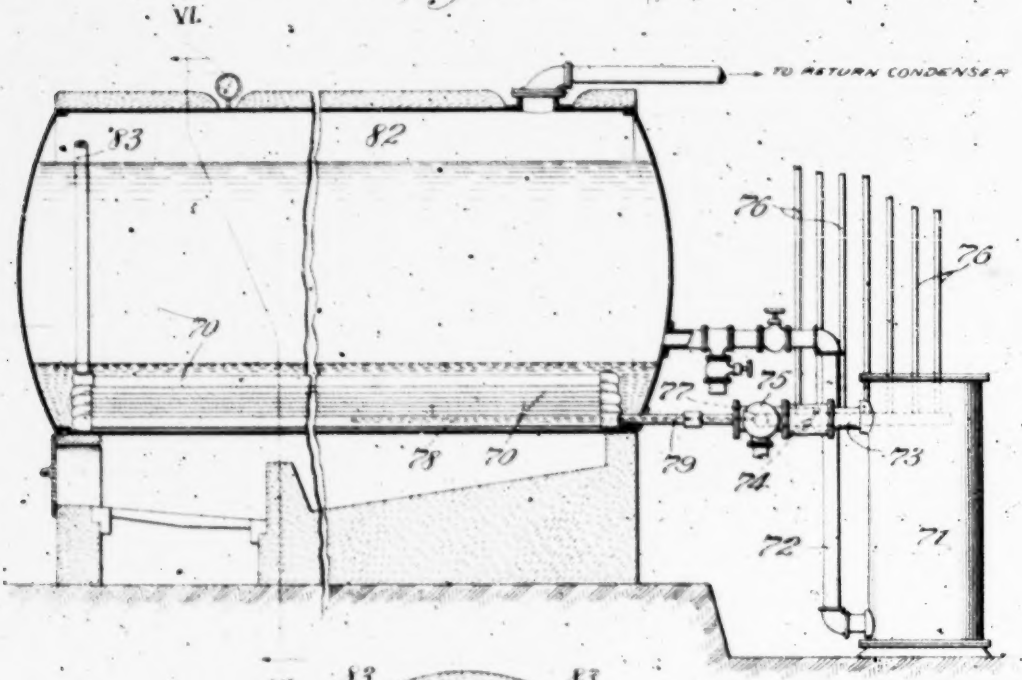
APPLICATION FILED NOV. 15, 1917.

1,288,711.

Patented Dec. 24, 1918.

3 SHEETS—SHEET 3.

Fig. 5.



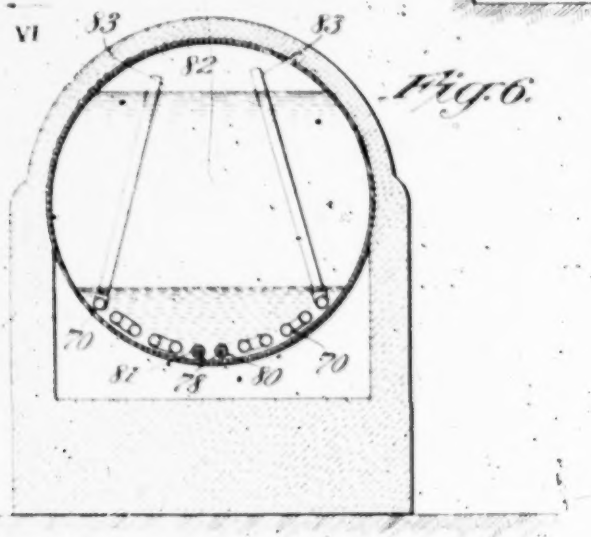


Fig. 6.

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UNITED STATES PATENT OFFICE.

LAYTON O. SHERMAN, OF EAST CHICAGO, INDIANA.

METHOD OF AND APPARATUS FOR DISTILLING PETROLEUM AND THE LIKE.

1,288,711. Specification of Letters Patent. Patented Dec. 24, 1918.

Application filed November 15, 1917. Serial No. 202,160.

To all whom it may concern:

Be it known that I, LAYTON O. SHERMAN, a citizen of the United States, residing at East Chicago, in the county of Lake and State of Indiana, have invented certain new and useful Improvements in Methods of and Apparatus for Distilling Petroleum and the like, of which the following is a specification.

This invention relates to the distillation of oils for the purpose of obtaining therefrom a maximum amount of low-boiling hydrocarbons of the motor-fuel type.

According to the invention the low-boiling portions are permitted to proceed to the condenser as formed while the higher-boiling fractions are separated from the vapors and reheated under such conditions as to effectively crack them.

The present invention is an improvement on those covered in my prior patent No. 968,088, dated Aug. 23, 1910, and my application filed April 24, 1916, Serial No. 93,180.

It has been found that very efficient cracking of the higher-boiling portions can be accomplished at a relatively low temperature if the period of heating is correspondingly prolonged. In the operation of my invention, a portion of the body of oil from the still proper and the higher-boiling fractions separated from the vapors in a return-condenser are passed through a long coil wherein they are subjected to a temperature exceeding that of the body of the oil in the still and thereby decomposed or cracked. Due to the extended duration of this step, however, the cracking temperature can be materially reduced. The vapors generated in this long coil mingle with any vapors evolved from the body of oil in the still and pass to the return-condenser. The low-boiling portions persist as vapors throughout the course of travel through the return-condenser while the higher-boiling portions are condensed and conveyed to the coil for further heating at the increased temperature with a portion of oil from the still.

The apparatus in its preferred form comprises a still of the ordinary cylindrical form having a fused metal false-bottom upon which the oil rests, a coil located in the furnace beneath the still or submerged in the fused false-bottom, so as to be subjected to a greater temperature than the body of oil in the still and open at its upper end to the vapor-space of the still, a separating-tower or return-condenser to which the vapors are conducted from the still and wherein the higher-boiling portions are condensed and thus separated from the lower-boiling portions, a conduit for conveying oil from the still to the lower end of the coil and conduits for conveying the condensed higher-boiling portions from various levels of the separating-tower to such lower end of the coil. If the coil is located in the furnace, it is preferably jacketed and the jacket filled with molten material, for instance, fused lead or lead-alloy. Means for separating out any carbon from the oil is interposed in the path of the oil flowing to the coil.

The invention will be better understood by reference to the accompanying drawings, wherein—

Figure 1 shows a vertical longitudinal section of the preferred form of apparatus;

Fig. 2 shows a vertical section along the line II—II of Fig. 1;

Fig. 3 is a sectional view of one of the manifolds and neighboring details;

Fig. 4 is a sectional view of one of the pipe-joints adjacent another manifold;

Fig. 5 is a fore-shortened longitudinal section of a modified form of apparatus; and

Fig. 6 is a transverse vertical section along the line VI—VI of Fig. 5.

In the form shown in Figs. 1 and 2, the cylindrical still 1 is mounted on a suitable furnace 2 sufficiently high above the fire-box of the latter to accommodate a coil or series of coils 3. Each of these coils comprises an inner pipe 4 for conveying the products to be superheated and an outer jacket 5 spaced from the pipe 4 to form an annular chamber 6 between the two. This chamber is filled with a molten material, such as lead or a lead alloy, which is fusible at a relatively low temperature. For filling the chamber with the molten metal, the jacket 5 may be provided with a removable plug 7. Upon removing the plug a threaded pipe of the height of the coil 3 and having a funnel top may be applied and the molten material poured in, or the annular chamber may be filled in any other suitable manner.

The coils 3 extend preferably from one end of the furnace to the other, a distance of, say, 30 feet, and the bends, of which there may be any suitable number per coil, may be conveniently supported in pockets 8 provided in the end-walls of the furnace. Additional support is desirable at or near the middle of the length of the pipes and

for this purpose brick or other supports 9 through openings in which the pipes pass are provided midway the length of the furnace. These supports may be carried by a protected steel cross-beam 10.

Except at their ends, the coils 3 are continuous or jointless, all return-portions thereof consisting of smooth bends as shown in Fig. 1. The upper ends of the coils, the latter lying preferably but not necessarily in vertical planes, are connected through threadless joints to couplings 11. A convenient method of effecting such a union is to insert the ends of each of the concentric pipes 4, 5 into the enlarged end of the member 11, with a spacing or filler-block 12 (see Fig. 4) inserted to close the end of the fused-metal chamber 6, and then weld the four layers of metal together in any suitable well-known manner. The coupling-members 11 connect the various coils 3 to an upper manifold 13 mounted transversely of the front furnace-wall, and the ends of this manifold are connected by pipes 14, 15 with the vapor-space 16 above the oil 17 in the still.

Adjacent the upper ends of the coils, the jacket is preferably provided with some means for permitting expansion and contraction of the fused metal between the pipes 4, 5. In the form indicated in Fig. 4, such means consists of a stand-pipe 18 welded or otherwise attached to the upper side of pipe 5, in which the molten metal may rise and fall. To prevent oxidation, a follower 19, comprising a disk of asbestos clamped between two disks of steel, floats on the metal in the well 18.

The furnace may be provided with any practicable number of units of coils 3, twelve thereof being shown in Fig. 2.

The oil in the still 1 preferably lies over a fused false-bottom 20 of lead or lead-alloy or other suitable material. Pyrometers or other temperature-measuring devices 21 may be inserted in the oil and fused false-bottom of the still and in the coil 3, at convenient places, and a pressure-gage 22 is provided on the still.

Above the still 1 and connected thereto by a pipe 23 is a return-condenser 24. This condenser may be of the type shown and described in my prior patent and application above referred to. It may be of some other type, however, and in some instances a tower of the well known dephlegmator form may be sufficient. It is desirable, however, that the tower be of such form and dimensions and offer such resistance to the flow of vapors therethrough that under the particular conditions of temperature, time and pressure of operation all products having boiling-points in excess of those of the low-boiling products desired, for instance, all which will not distil at or about 400° F., will be condensed in the tower. In towers of the dephlegmator type or of the construction disclosed in my prior patent and application, the condensed higher-boiling portions can be separately drawn off from the various zones of condensation in the tower, according to their various degrees of volatility and such forms are therefore preferred. In Figs. 1 and 2, two of such towers are shown and they may be operated together in multiple or alternately.

The pipe 23 has two branches 25, 26, Fig. 2, leading to the bottoms of the two condensers 24 through elbows 27, 28. A filling-valve 29 may be provided in the pipe 23 as may also a shut-off valve 30. The passages to the return-condensers may be controlled by suitable valves such as that shown at 31. Pipe 32 conveys the uncondensed low-boiling products from the tops of the towers to a suitable condenser, not shown. Connected to the towers 24 at diametrically opposite points and at various heights are draw-off pipes 33—39 for collecting the condensed higher-boiling portions. The number of these draw-off pipes will depend upon the height of the tower and the height of the tower will in turn depend upon the pressure of operation. In general, the higher the tower the lower the pressure of operation, since increased height of tower gives increased condensing surface and less resistance to flow through the tower. The collecting pipes 33—39 of each height are connected to separate return-pipes 40—46 and the latter discharge into a manifold 47 substantially on the level with the lower ends of the coils 3. This manifold runs along the outside of and parallel to the rear wall of the furnace opposite the lower ends of the coils 3 and discharges the higher-boiling portions into such coils through jet-pipes 48. These jet-pipes extend a considerable distance into the coils 3 for a purpose presently to be described. A check-valve 49 Fig. 2 is provided in the manifold 47 between the connections thereof with the return-pipes 40—46 and the first of the jet-pipes 48.

Connected to the still 1 just above the level of the fused-metal false-bottom 20 is an oil-outlet pipe 50 having branches leading to the upper ends of carbon-separators 51 of which two are represented in the drawings. These may be operated in multiple but are preferably used alternately so that one may be cleaned while the other is in use. Suitable valves may be provided in the branch-pipes for this purpose. For the purpose of entirely shutting off the flow of oil through the pipe 50, a valve 52 is provided and to enable withdrawal of the residues from the still, a valved sludge-pipe 53 is connected to such pipe 50.

The carbon-separating device 51 may be

of any suitable type, for instance, one with a baffled interior arrangement, but I prefer a separator of the filter type using pebbles or the like supported on trays and varying in fineness from coarse to quite fine. In some cases, a fine mineral substance such as fuller's earth may be used near the end of travel of the oil through the filter. Oil-outlet pipes 54 are connected to the separators at or near their bottoms and convey the filtered oil to a manifold 55, which for substantially the width of the furnace incloses concentrically the return-condensate manifold 47. Check-valves 56 are provided in the pipes 54. The opposite side of the manifold is connected by suitable welded joints (see Fig. 3) to the lower end of each of the coils 3, the openings 57 of the manifold passage registering with the openings 58 of the inner pipes 4 of the coils 3. The jet-pipes 48 of the inner manifold 47 extend through the passages 57, 58 well into the pipe 4, as indicated in dotted lines in Fig. 1. Oil from the carbon separators 51 thus enters the coils 3 through the passages 57, (Fig. 8) 58 while the condensate from the return-pipes 40—46 under a head of pressure is forcibly admitted to the coils 3 through the jet-pipes 48.

In case the feeding of the oil from the carbon-separator to the coils 3 becomes sluggish, a circulating-pump 59 is cut in. This pump takes in oil from the carbon-separator 51 through a valved pipe 60 and discharges it through a pipe 61 into the manifold 55. The pipe 61 is provided with a swinging-check 62 and a pressure-gage 63 is located on the pipe between the valve 62 and the manifold 55. To permit filling of the still and the coil system with oil by means of the pump 59 a valved oil-feed pipe 64 is connected to the intake side of the pump.

In operating, a shallow puddle of the fused material composing the false-bottom 20 is formed in the still 1 and oil, which may be crude petroleum, crude-oil residue, or a middle-distillate, is supplied to the system either through the valve 29 in the vapor-line 23 or by means of the pump 59 through pipes 64 and 61 and manifold 55, until the still is, say, four-fifths full, the valves in pipes 53 and 60 and the valve 30 being meanwhile closed, of course. The filling-valve 29 or the valve in the pipe 64 as the case may be, is then closed and the valve 52 opened. The jackets of the coils 3 are filled with molten lead-alloy or other suitable fused material through the filling-plug 7. The furnace is then gradually heated up, preferably until oil in the still vaporizes. If the material operated upon is a crude-oil, the valves leading to the tower 24 are opened from the outset and the vapors comprising the low-boiling fractions of the oil are allowed to proceed through the tower to the condenser at once. When the low-boiling fractions have passed off and the gravity of the distillate drops below that permissible or desirable, the valve 30 is closed or partly closed to produce pressure in the still 1. In case middle-distillates are being treated, the valve 30 is closed or partly closed at the start so that pressure in the still develops at once as the temperature of the oil 17 rises. Vaporization is effected at as low temperatures as possible, but toward the close of the operation on a batch, it may be necessary to run as high as 750° F.

When the pressure on the vapors in the still has risen to a sufficient height, say 25 pounds, the valve 30 in the vapor-pipe 23 is opened a little to enable some of the vapors to pass to the tower 24 while pressure is maintained in the still. If the vapors passing to the tower or return-condenser contain any low-boiling products, these will persist as vapors throughout the course in the tower and will pass directly to the condenser through the pipe 32. Such condensing may be under pressure, as described in my prior application, but I prefer to operate in such manner that the pressure is just reduced to atmospheric when the vapors reach the main condenser. This can be accomplished by proper dimensioning and construction of the towers and regulation of the temperature of operation and the pressure in the still,—conditions which must be determined by experiment in each particular case. As the temperature of vaporization of the mass of oil rises, the pressure in the still must be progressively increased, slightly, to maintain the yield of low-boiling condensate uniform so far as possible both in quantity and gravity.

The higher-boiling fractions, say of less than 50° B. gravity, are condensed in the tower 24 at one level or another, are collected by the draw-off pipes 33—39, conveyed to the return-pipes 40—46 and pass into the collecting manifold 47 which soon fills in the course of operation. This condensate also collects in the pipes 40—46, which are veritable stand-pipes, until the gravity pressure on the portion in the manifold 47 is sufficient to overcome the pressure in the pipes 4, which pressure is at the start the same as that in the vapor-space 16 of the still into which the pipes 4 open, whereupon the check-valve 49 is opened and the condensate flows through the jet-pipes 48 into the pipes 4. The temperature in the pipes 4 is somewhat higher than that of the oil in the still 1 and the lower-boiling portions of the condensate fed in through the jet-pipes 48 become vaporized almost as soon as they enter the jet-pipes and, since they are prevented by the check-valve 49 from moving backward toward the tower 24, they emerge from the inner ends of the pipes 48

with considerable force, as jets. Oil from the still 1 which enters the pipes 4 through the passages 57, 58 is not only drawn into the pipes 4 by this injecting action of the vapors issuing from the jets 48, but such oil is caused to thoroughly mix with the condensate which is returned from the condenser 24. This mixture of pre-heated oil and condensate from the tower becomes heated in the coils 3 to a cracking temperature but one which can be exceedingly low for the material being treated as the time of cracking is considerably prolonged by the length of the coils.

The temperature in the cracking-coils 3 increases, of course, as the vaporizing temperature in the still increases. The average range of cracking-temperature is from 675° F. to 750° F. and the first 35 per cent. of a batch of oil should be converted into low-boiling fractions of desired gravity, say 58°–63° B., at temperatures not exceeding 715° F. The temperature of the body of oil in the still during this period may run between 650° F. and 700° F.

As the cracking occurs in the coils 3, the pressure therein is considerably increased and the gaseous products are driven out of the upper end of the pipe 14 into the vapor-space 16 of the still where they mingle with the vapors thereof and pass to the return-condenser where the high- and low-boiling portions are separated as before, the former being collected in the pipes 33—39 and returned to the superheating coils 3, while the low-boiling portions pass on to the main condenser.

When the apparatus is properly adjusted as to temperature and pressure and therefore speed of operation, the vertical portions of pipes 40—46 are progressively cooler as they connect with the higher zones of the return-condenser. That is, pipe 46 is hot, pipe 45 is not quite so hot as 46, and so on, pipe 41 being only slightly warm while pipe 40 is cool. Under such conditions it is evident to the operator that the system is now gas-bound and that the desired products are being recovered.

In case of suspension of operation, the valve 52 which controls the passage of oil to the carbon-separator 51 is closed. Thereby no further oil is fed into the coils 3 although the high-boiling condensate will continue to flow into the coils from the return-condenser for a considerable length of time—in fact until the still is practically cool. By this means, the inner pipes 4 of the coils 3 are scoured by the condensate so long as there is any substantial heat in the furnace and there is no chance for formation of coke therein.

In the form of apparatus shown in Figs. 5 and 6, the superheating or cracking-coil 70 is submerged in the fused false-bottom. The arrangement is in part similar to that shown in my prior application. However, I have found it desirable to connect the pipe or pipes which return the high-boiling condensate to the bottom of the coil instead of to one of the upper turns.

As in the case of the form shown in Figs. 1 and 2, oil from the still is introduced into the cracking coil along with the return condensate after being first subjected to a carbon-separating step. The flow of oil through the filter 71 takes place in an upward direction in the form shown, oil entering the separator at or near the bottom through a valved pipe 72 and discharging at or near the top into a pipe 73 supplied with a check-valve 74 and which leads to a manifold 75 similar in construction to the manifold 55 in Figs. 1 and 2. The inner concentric manifold which supplies the returned condensate from the return-pipes 76 to the jet-pipes in the submerged coil is indicated at 77. The jet-pipes, of which there are preferably two, are shown at 78. The pipe 79 connecting the manifold 75 with the coil 70 has two branches, one connected with the lower turn 80 of the coil 70 while the other connects with the other lower turn 81 of such coil 70. The gases produced in the coil 70 thus pass upwardly in the coil along the opposite sides of the still and pass into the vapor-space 82 of the still through pipes 83 at the two ends of the coil. As in the first form of apparatus shown, the jet-pipes 78 extend a considerable distance into the pipe sections 80, 81 for the purpose hereinbefore described.

The operation of this apparatus is substantially the same as that described for the construction shown in Figs. 1 and 2 and further description is not thought necessary.

It will be obvious that many changes in the details of construction and operation may be made without departing from the spirit and scope of my invention.

I claim:

1. The method of distilling oil which consists in vaporizing a portion thereof; separating from the vapors the higher-boiling portions, subjecting the latter mixed with a portion of oil from the still to a prolonged heat at a low cracking temperature whereby the mixture is substantially completely cracked, and condensing the low-boiling products.

2. The method of distilling oil which consists in vaporizing a portion thereof, separating in various zones according to volatility the higher-boiling portions, subjecting the latter mixed with a portion of oil from the still to a temperature in excess of that of the vaporizing temperature of the oil in the still and condensing the low-boiling products.

3. The method of distilling oil to obtain

low-boiling products, which comprises heating the oil under pressure to vaporize a portion thereof, condensing the higher-boiling portions of the distillate, heating said condensed higher-boiling portions together with a portion of oil from the still to a temperature above that of the oil and at a pressure above that of initial vaporization and condensing the low-boiling products.

4. The method of distilling oil which consists in vaporizing a portion thereof, separating from the vapors the higher-boiling portions, injecting into a cracking zone a portion of oil from the still by means of said higher-boiling portions and condensing the low-boiling products.

5. Apparatus for distilling oil, comprising a still, a return-condenser connected therewith, a pipe open at one end to the vapors passing to said return-condenser, means for heating said still and said pipe, the latter to a greater temperature than the oil in the still, means for conveying oil from said still to the other end of said pipe, and means for conveying the higher-boiling portions from said return-condenser to said other end of the pipe.

6. Apparatus for distilling oil, comprising a still, a coil open at its upper end to the vapor-space of the still, a return-condenser adapted to receive the vapors from said still, means for heating said still and said coil, the latter to a greater temperature than the oil in the still, means for conveying oil from said still to the lower end of said coil, and means for conveying the higher-boiling portions from said return-condenser to said lower end of the coil.

7. Apparatus for distilling oil, comprising a still, a furnace beneath said still, a return-condenser adapted to receive the vapors from said still, a coil beneath the still having its upper end open to said vapors, means for conveying oil from said still to the lower end of said coil, and means for conveying the higher-boiling portions from said return-condenser to said lower end of the coil.

8. Apparatus for distilling oil, comprising a still, a return-condenser adapted to receive the vapors from said still, a pipe open at one end to said vapors, means for heating said still and said pipe, the latter to a greater temperature than that of the oil in the still, a conduit for conveying oil from said still to the other end of said pipe, means interposed in said conduit for separating carbon from the oil as it flows to said pipe, and means for conveying the higher-boiling portions from said return condenser to said other end of the pipe.

9. Apparatus for distilling oil, comprising a still, a furnace beneath said still, a return-condenser adapted to receive the vapors from said still, a coil of pipe beneath the still having its upper end open to said vapors, a conduit for conveying oil from said still to the lower end of said coil, means interposed in said conduit for separating carbon from the oil as it flows to said coil, and means for conveying the higher-boiling portions from said return condenser to said lower end of the coil.

10. Apparatus for distilling oil, comprising a still, a fused-metal false-bottom in said still, a pipe open at one end to the vapor-space of the still, means for heating said still and said pipe, the latter to a greater temperature than the oil in the still, means for separating the higher-boiling portions from the vapors from said still, means for passing oil from the still immediately above the fused false-bottom into the other end of said pipe, and means for conveying the separated higher-boiling portions to said other end of said pipe.

11. Apparatus for distilling oil, comprising a still, a return-condenser connected therewith, a furnace beneath said still, a jacketed coil beneath the still having its upper end open to the vapor-space of the still and the jacket thereof being filled with molten material, means for conveying oil from said still to the lower-end of said coil, and means for conveying the higher-boiling portions from said return-condenser to said lower-end of said coil.

12. Apparatus for distilling oil, comprising a still, a return-condenser connected therewith, a coil open at its upper end to the vapor space of the still, means for heating said still and said coil, the latter to a greater temperature than the oil in the still, a conduit for conveying oil from said still to the lower end of said coil, a check-valve in said conduit, a conduit for conveying the higher-boiling portions from said return-condenser to said lower end of the coil, and a check-valve in said conduit.

13. Apparatus for distilling oil, comprising a still, a return-condenser connected therewith and having independent draw-off pipes connected thereto at various zones of condensation, a coil open at its upper end to the vapor-space of the still, means for heating said still and said coil, the latter to a greater temperature than the oil in the still, means for conveying oil from the still to the lower end of said coil, and a manifold to which said draw-off pipes are connected, said manifold opening into said lower end of said coil.

14. Apparatus for distilling oil, comprising a still, a furnace beneath said still, a coil beneath said still having its upper end open to the vapor-space of the still, a return-condenser adapted to receive the vapors from said still and having independent draw-off pipes connected thereto at its various zones of condensation, means for conveying oil from the still to the lower end of said coil,

and a manifold to which said draw-off pipes are connected, said manifold opening into said lower end of said coil.

15. Apparatus for distilling oil, comprising a still, a furnace beneath said still, a coil beneath said still having its upper end open to the vapor-space of the still, a return-condenser adapted to receive the vapors from said still and having independent draw-off pipes connected thereto at its various zones of condensation, a conduit for conveying oil from said still to the lower end of said coil, a carbon-separator interposed in said conduit, and a manifold to which said draw-off pipes are connected, said manifold opening into said lower end of said coil.

16. Apparatus for distilling oil, comprising a still, a furnace beneath said still, a jacketed coil beneath the still having its upper end open to the vapor-space of the still and the jacket thereof being filled with molten material, a return-condenser adapted to receive the vapors from said still and having independent draw-off pipes connected thereto at its various zones of condensation, means for conveying oil from the still to the lower end of said coil, and a manifold to which said draw-off pipes are connected, said manifold opening into said lower end of said coil.

17. Apparatus for distilling oil, comprising a still, a coil open at its upper end to the vapor space of the still, a return condenser adapted to receive the vapor from said still, means for heating said still and said coil, the latter to a greater temperature than the oil in the still, a conduit for conveying oil from said still to the lower end of said coil, and means for conveying the higher-boiling portions from said return-condenser a substantial distance into said lower end of said coil whereby such portions vaporize and provide injecting-means for the oil.

18. A pipe for use in distilling oils, comprising an inner pipe adapted to conduct the fluid to be heated, and an outer jacket substantially concentric with said inner pipe to form a chamber between the two, said chamber being filled with metal fusible at a relatively low temperature and means for allowing the fusible metal to expand.

19. A heating coil for use in distilling oils, comprising an inner pipe adapted to conduct the fluid to be heated, and an outer pipe coextensive therewith to define a chamber of annular cross-section, said chamber being filled with a metal fusible at a relatively low temperature and means for allowing the fusible metal to expand.

20. A heating coil for use in distilling oils, comprising an inner pipe adapted to conduct the fluid to be heated, an outer pipe coextensive therewith to define a chamber of annular cross-section, said chamber being filled with a metal fusible at a relatively low temperature and an expansion chamber to allow the fusible metal to expand.

In testimony whereof I affix my signature.

LAYTON O. SHERMAN.

3318

A. F. G. P. J. VON GROELING.

PROCESS OF AND APPARATUS FOR DISTILLING CRUDE OIL AND OTHER HYDROCARBONS.

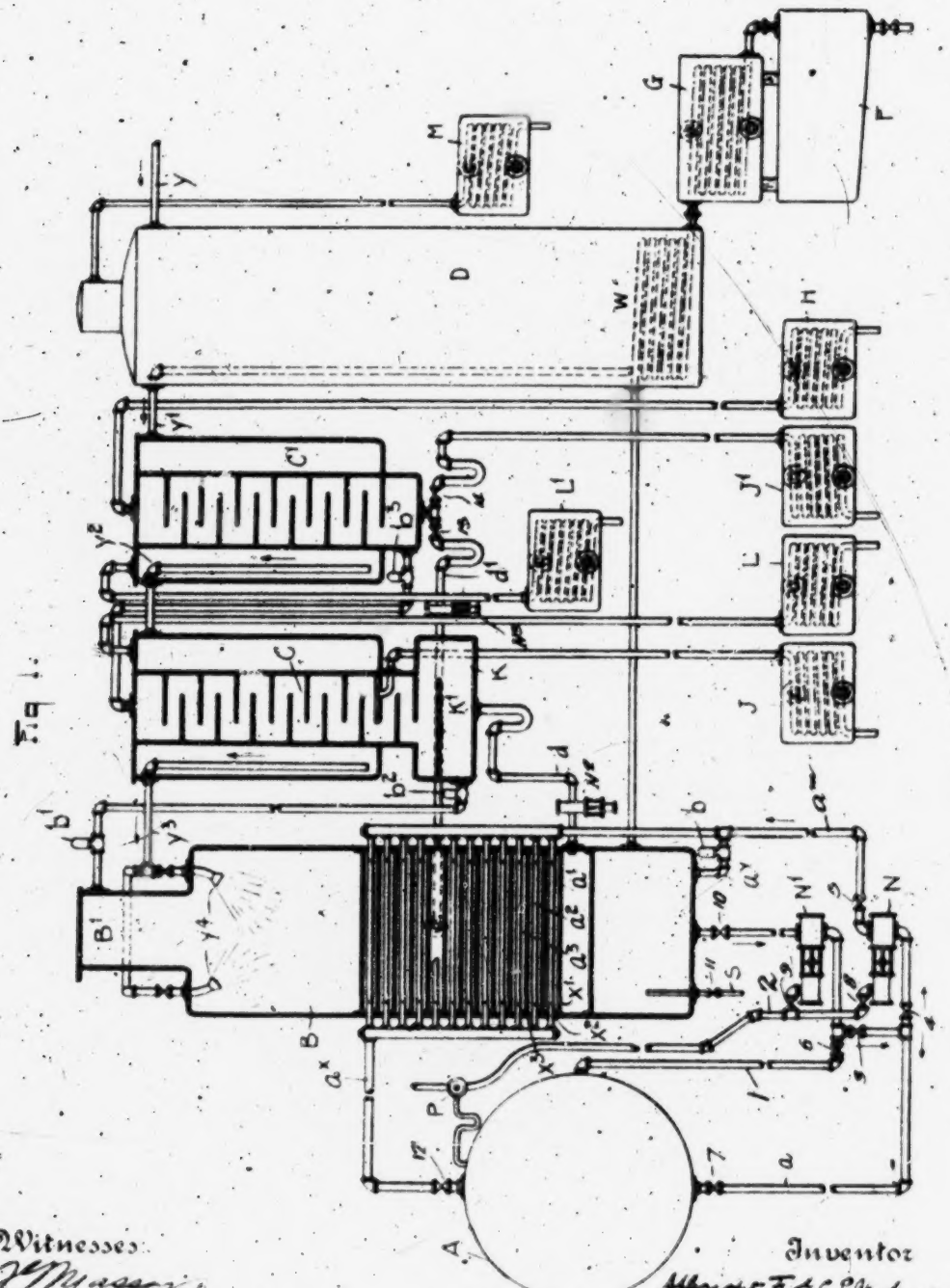
APPLICATION FILED APR. 23, 1915.

1,295,088.

Patented Feb. 18, 1919.

2 SHEETS—SHEET 1.

Fig 1.



Witnesses.

Inventor

By his Attorneys

3320

A. F. G. P. J. VON GROELING.

PROCESS OF AND APPARATUS FOR DISTILLING CRUDE OIL AND OTHER HYDROCARBONS.

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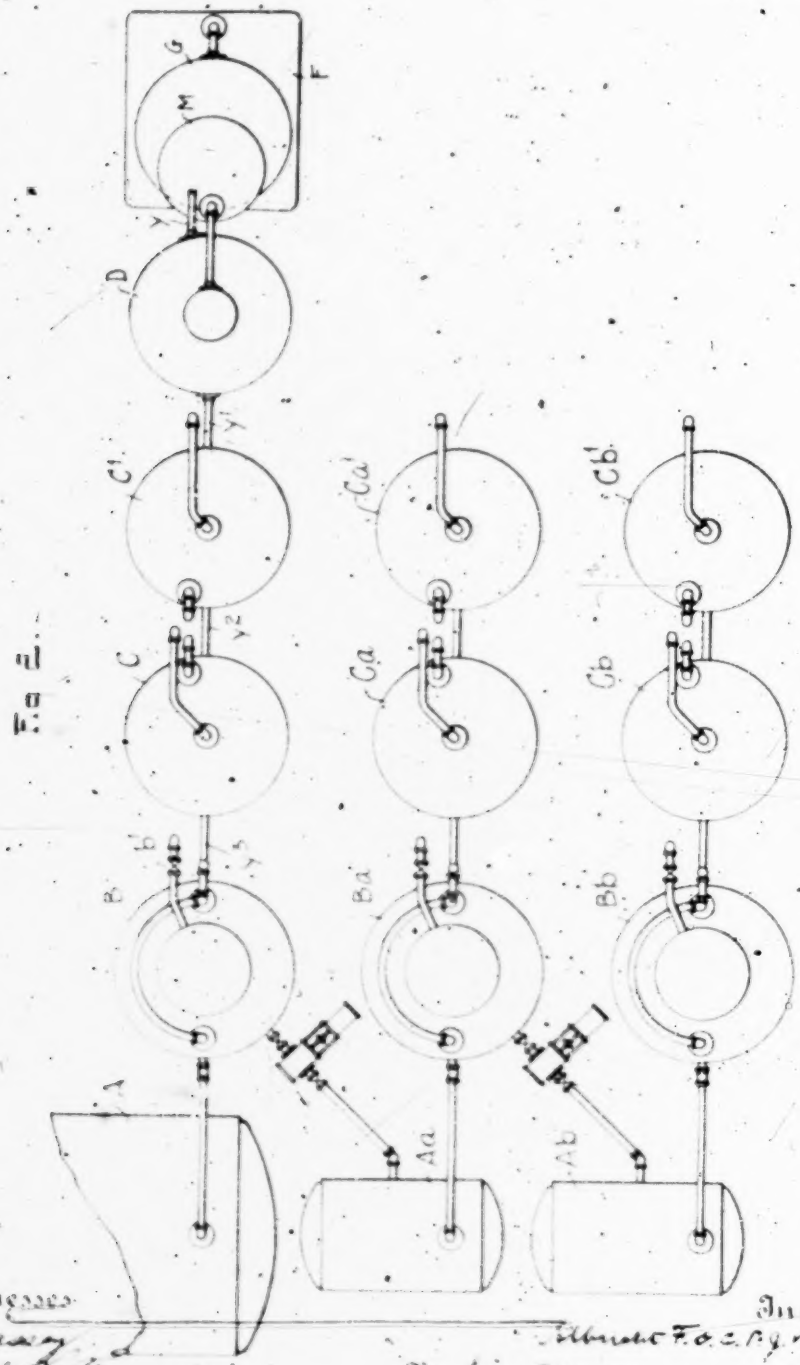
2 SHEETS—SHEET 2.



Witnesses:

Inventor

By his Attorneys

3321

UNITED STATES PATENT OFFICE.

ALBRECHT FRIEDRICH GEORG PAIL JOSEF von GROELING, OF COFFEYVILLE, KANSAS, ASSIGNOR TO ATLAS PROCESS COMPANY, INC., OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

PROCESS OF AND APPARATUS FOR DISTILLING CRUDE OIL AND OTHER HYDROCARBONS.

1,295,088. Specification of Letters Patent. Patented Feb. 18, 1919.

Application filed April 23, 1915. Serial No. 23,411.

To all whom it may concern:

Be it known that I, ALBRECHT F. G. P. J. von GROELING, a subject of the Emperor of Austria, and a resident of Coffeyville, in the county of Montgomery and State of Kansas, have invented a certain new and useful Process of and Apparatus for Distilling Crude Oil and other Hydrocarbons, of which the following is a specification.

This invention relates to processes and apparatus for distilling crude oil and other hydrocarbons; and it comprises, briefly, as a process, a process of distilling such oils by heating part of the same under pressure and utilizing the highly heated oil under pressure for combining with the oil in the still by introducing the same through a pressure reducing or expansion valve so that the highly heated oil upon reduction in pressure is vaporized and acts upon the oil in the still, or for both heating the still and for combining with the oil therein; it also comprises such a process in which the oil flowing to the still and the distillate therefrom are brought into heat interchanging relation with each other in opposite directions whereby the distillate is cooled and condensed and the oil preheated and freed from its more volatile constituents before reaching the still; and as an apparatus it comprises a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, said still having therein heating coils arranged between trays or baffles forming separate chambers, a boiler for heating part of the oil under pressure, means for introducing oil from the still into the boiler and for circulating the heated oil from the boiler through the heating coil, and means including a pressure reducing valve or expansion valve for introducing part of the heated oil into the still; it also comprises certain novel combinations of such apparatus with dephlegmators, preheaters, etc., whereby the heat of the still distillate is utilized in preheating the oil with resulting advantage and economy; and it further comprises certain novel steps and combination of steps of the process, and certain novel combinations and arrangements of the apparatus; all as more fully hereinafter set forth and as claimed.

In the distillation of crude oils it is important that the oil should be separated into certain more or less distinct fractions. In some cases the more volatile petrol or gasolene, or even kerosene, fractions only are removed, leaving the fuel oil which may or may not be further separated. Again it may be desirable to carry out the fractionation more completely and separate the oil into further fractions, and particularly to break up the heavier oils into the more valuable lighter fractions. When treating crude oil near its source it is necessary to treat large amounts of oil continuously, and in many cases only a rough fractionation is effected, such as the removal of the lighter fractions from the fuel oil, and of the fuel oil from the lubricating oil, etc.

It is an object of the present invention to simplify the distillation of such oils, and to obtain in a single apparatus and with a continuous process an efficient and inexpensive separation of the oil, and certain valuable products. It is a further object of the invention to utilize the heat of the main still distillate for preheating the crude oil and for separating therefrom its more volatile constituents, so that the complete process can be effected by the heat supplied to the main boiler and still, and so that there will be a gradual increase in temperature of the oil entering the apparatus and a progressive fractionation thereof, and also so that there will be a progressive condensation of the distillate and separation thereof into the desired fractions, the temperature of the apparatus being gradually increased or decreased in successive stages of the process and apparatus from the temperature of the crude oil and condensed distillate to the intense heat of the boiler and still. Other objects of the invention will appear from the following more detailed description.

I will now proceed to describe my invention more in detail with particular reference to the accompanying drawings illustrative of certain embodiments of the apparatus of the invention, in which the novel process of the invention can be practised, it being intended and understood that the invention will be illustrated by, but is not limited to, the specific embodiments thereof so illustrated and described.

In the accompanying drawings Figure 1

shows more or less diagrammatically a partial elevation and partial vertical section of apparatus embodying my invention; and Fig. 2 shows a plan view of the apparatus shown in Fig. 1 and also shows similarly other boilers, stills, dephlegmators, etc., arranged to cooperate with the first series of apparatus.

This apparatus comprises a boiler A arranged to be suitably heated to the desired temperature by any suitable heating means (not shown) and constructed to withstand the pressure to which the oil within it may be subjected. The still in which the main distillation is effected is illustrated at B, and a series of dephlegmators (consisting of two dephlegmators in the particular construction shown) are illustrated at C and C′, these dephlegmators being so connected with the still B that the distillate from the top of the still is led first to the bottom of the dephlegmator C in which is arranged a baffle chamber K for separating heavier particles, thence up through the dephlegmator C, from the top thereof to the bottom of the dephlegmator C′, from the top of which the uncondensed distillate is led to a condensing coil H, and is condensed therein and collected as it flows therefrom. A preheater is shown at D, arranged to be heated by a coil W which receives the residue from the bottom of the still B; such residue passing from the coil W to the cooler G and finally to the residue tank F. The crude oil is fed into the preliminary heater D through the inlet pipe y, this feed being effected, preferably continuously, by a pump or in any suitable manner. From the preliminary heater the oil overflows through the pipe y' to the jacket of the dephlegmator C′; from which jacket it flows by the pipe y^2, leading from near the bottom of the jacket, to the jacket of the dephlegmator C, from which it flows through the pipe y^3 and the spray nozzles y^4 into the top of the still B. A suitable condenser M is provided to condense the vapor produced in preheater D, and other suitable condensers L and L′ are provided for condensing the vapor produced in the jackets of dephlegmators C and C′. Suitable coolers J and J′ are also provided for cooling the liquid escaping from the lower levels of the dephlegmators C and C′ respectively. Return pipes d and d' connect the bottoms of the dephlegmating columns C and C′ respectively with the still B, the return pipe d entering near the bottom of the still and the return pipe d' entering at an intermediate point. Pumps N^2 and N^3 are provided in these return lines d and d' to force the residues in these dephlegmators into the still. From the bottom of the still B a pipe connection e leads to a pump N′ which pumps the oil under pressure into the boiler A, this pump being constructed and arranged to maintain the desired predetermined pressure within the boiler. Also connected with the boiler A is a pipe a leading from the bottom of the boiler to a pump N and a pipe a^m leading from the pump N to a series of coils a', a^2, a^3, etc., from which the pipe a^1 leads back to the top of the boiler. Between the pipe a and the bottom of the still B is a connection a^7 having therein a suitable pressure reducing or expansion valve b by means of which the high pressure oil in the pipe a can be introduced at a lower pressure into the bottom of the still. The coils a', a^2, etc., are arranged within the still between perforated trays or baffles x^1, x^2, x^3, etc., which divide the central part of the still into separate chambers, each containing one of the heating coils. It will be understood that suitable valves such as 3—12 inclusive are provided where desired for controlling the flow of the oil or of the distillate and for maintaining the desired pressure conditions within the apparatus, thus the outlet for the distillate from the top of the still B may be provided with a regulating or reducing valve b'; and the other inlet and outlet connections may be similarly arranged to enable the desired pressure to be maintained within the still. A valved steam inlet s is indicated at the bottom of the still through which steam can be introduced when desired.

The operation of the apparatus above described, and the process as practised therein will now be described. Assuming that the apparatus is to be started and that it does not contain any oil, the crude oil will be pumped continuously through the inlet y to the preliminary heater D from which it will overflow into the jackets of the dephlegmators or preheaters C′ and C and thence into the still B by means of the pipe connections y', y^2, y^3, and the spray heads y^4. The preheaters D, C, and C′ will be filled to the level of the overflows. In the still B the oil passes down over the baffles or sieves and drips down to the bottom of the still. From the bottom of the still it is fed by the pump N′ and pipe 1 into the boiler A until the desired level is obtained therein; in practice, the boiler A is filled, nearly or completely. The boiler A is then heated, and since there is no outflow while the oil is being pumped in, (until out-flow through valve b starts, as hereinafter described, at which time oil is pumped into the boiler through pump N′ to maintain the pressure) a pressure will be maintained sufficient to keep the oil in a liquid condition even when heated considerably above its boiling point at atmospheric pressure. In this way, the oil in the boiler may be heated to a cracking temperature, and yet maintained in that boiler in a liquid condition, owing to absence of vapor space in the boiler in which that oil may vaporize. The

pump N is started and circulates the heated liquid through the pipes a, a^m, a^1, a^2, a^5, etc., and a^x, taking the oil from near the bottom of the boiler A and forcing it up through the coils within the still B to the top of the boiler A. When the pressure within the pipe system a is greater than that at which the relief valve b is set, part of the oil will be discharged through this valve b and the pipe a^7 into the still and will be vaporized at the lower pressure within the still. Accordingly, when the apparatus is in continuous operation, a discharge of the heated oil from the high temperature and pressure of the boiler A and of the pipes a and a^m will be continuously effected through the reducing valve b, while at the same time circulation of the highly heated and high pressure oil will be effected from the boiler through the heating coils a^1, a^2, etc., arranged in the still B. The pressure within the boiler will be maintained automatically by means of the pump N' which is controlled by an automatic pressure-controller P controlling supply of steam through pipe 2 to this pump in such manner that it will operate to pump oil into the boiler or into the pipe system a as soon as the pressure within the boiler falls below a predetermined amount. The pressure within the boiler is advantageously such that the oil will be maintained in a liquid state and distillation or vaporization prevented, notwithstanding the temperature to which that oil may have been raised; and in addition, it is preferable that the oil fill the boiler substantially completely, so that there may be no space therein in which vapor may form. The temperature of the oil will accordingly correspond to this pressure, and this temperature may be considerably higher than that within the still, so that when the oil is discharged through the reducing valve b, the reduction in pressure as the oil passes from valve b into the still will result in converting a greater or less amount of this oil into vapor, which vapor will itself rise in the still and will tend to vaporize and carry with it more or less of the oil in the bottom of the still, particularly the more volatile constituents. If the oil in the boiler has been heated to cracking temperature, as may be the case, and has remained at such temperature for the time required for cracking, then upon the discharge of the oil from pipe a^7 into the still, the several fractions into which the oil has been cracked will evaporate more or less successively. The vapors rising in the still will meet the downflowing oil, heating it, dissolving it, combining with it, dephlegmating it, and distilling it. The rising vapors and the descending liquid will be intimately intermingled by the sieve-like baffles x^1, x^2, x^3, etc., and the mixture will be further heated and vaporized by the heating coils arranged in the chambers between the baffles. The result of the action taking place in the still is to give an oil residue at the bottom of the still having a relatively higher boiling point, and to give a distillate having a relatively lower boiling point. The vapors rising in the still collect in the dome B' and then pass on first to the dephlegmating column C, entering this column at the bottom and being first deflected by a baffle K' within separator K; upon which separator the dephlegmating column C is mounted. By means of this baffle the heavier particles and those mechanically carried along are separated and caused to settle at the bottom in the form of liquid which is returned by the return pipe d to the still. From the separator K the vapors pass up through the main column C where they are in part condensed by the cooling action of the surrounding oil, the condensed distillate being drawn off from the lower levels to the condenser J. From the top of the column C the vapors pass through the bottom of the column C' where a further separating and dephlegmating action takes place. From the bottom of this column the condensed liquid can be either returned to an intermediate chamber of the still B or led to the condenser J', suitable regulating valves 13 and 14 being provided for regulating such flow. From the top of the column C' the uncondensed vapors pass to the condenser H. During the passage of the distillate through the columns C and C', in which columns the gases are baffled and made to take a circuitous path, they give up heat to the surrounding incoming oil which is thereby preheated. It will thus be seen that the distillate is progressively cooled and condensed while the incoming oil, flowing in the opposite direction, is progressively heated, the incoming oil thus acting as a condenser for the distillate, and the distillate acting to preheat the incoming oil. The incoming oil will be first preliminarily heated in the preheater D by the residue from the bottom of the still, and will then be further and successively heated in the jackets of the dephlegmators. I do not limit myself to any particular number of dephlegmators in the series; a greater or less number may be used, and the degree of fractionation obtained will depend in large measure on the number of such dephlegmators used. Moreover, preheating of the crude oil, in preheater D and in the jackets of the dephlegmators, and the preliminary distillation of the more volatile constituents from the incoming oil, is effected without any application of heat other than the heat of the distillate. From the tops of the various preheaters the more volatile fractions or constituents of the crude oil will be progressively removed, a preliminary fractionation of the crude oil being thus effected, with the result that the crude oil is "topped" or separated from the more volatile by-prod-

ucts which form in themselves valuable constituents of the oil, but which are not desired in oil used for fuel and other purposes. From the various condensers the products obtained can be led to any suitable retainers or storage receptacles. It will be understood that the various condensers and coolers can be cooled by crude oil as well as by water, and that the crude oil can be thereby further heated, suitable connections being provided for circulating the crude oil and recovering any volatilized constituents. The residue which accumulates in the main still B will be of a relatively higher boiling point, and this residue can be subjected to further treatment in any desired manner. Such residue may advantageously be further treated in a further still B^a (Fig. 2) in which it is introduced at the top, and in which it is heated and further fractionated or treated in much the same manner as is the oil in the still B. A series of such stills, B, B^a, B^b, etc., (Fig. 2) each having its appropriate dephlegmators C, C′, or C^a, $C^{a\prime}$, or C^b, $C^{b\prime}$, etc., can be connected together so that all fractions from the highest to the lowest, or from the lightest to the heaviest, can be obtained from a single apparatus, suitable pump connections being made for effecting the circulation from each still into the next and for removing from each still the various fractions formed therein. When a plurality of such stills are used together, each may have its separate boiler, A, A^a, A^b, etc., maintained under the necessary heat and pressure, and operated in a manner already described. With such a series, the crude oil can be treated to obtain from it all its various fractions including the heavy lubricating oil and the pitchy residue.

Where it is desired to use the apparatus for cracking purposes, the pressure within the still B can be increased by providing the outlets therefrom with suitable regulating valves such as 7, 3 and 4, and by introducing the oil therein under pressure. In such case the pressure and temperature of the boiler A may advantageously be higher than that of the still so that the heated oil from the boiler can still be expanded through the valve *b* and vaporized within the still, and so that the heating coils within the still will still exert the desired heating action. A most intimate intermingling of the rising vapors and of the descending liquid is effected as they pass over the baffles and heating coils, and the rising vapors act not only to vaporize the oil but they combine within it and favorably influence the cracking process. The expansion of the high pressure and temperature gases into the still is also advantageous in the cracking process, since the relieving of the pressure, and the conversion of the liquid into a vapor at a high temperature, is advantageous in such process.

The process and apparatus of the present invention are of particular value where it is desired to separate from crude oil the main fuel fraction from the more volatile constituents on the one hand, and from the heavier residues on the other. The process is also advantageous for obtaining a larger yield of the liquid fuel. It will be understood that the different fractions obtained can be further purified and fractionated. Where the crude oils contain impurities such as sulfur, these will require subsequent purification. The process and apparatus of the present invention enable a rough separation of the crude oil to be advantageously effected by the application of heat at one point only and by the utilization of the heat of the main distillate for preheating the inflowing crude oil. The arrangement is such that the hottest distillate is used for heating the crude oil which has already been heated by the cooler distillate, and vice versa. When desired superheated steam can be introduced at the bottom of the still through pipe *s* in addition to petroleum vapors through pipe a^3. Such addition of steam is desirable in some cases to sweeten the benzin or other fraction. The introduction of the petroleum vapors however is particularly advantageous in the operation of the process within the still since such vapors act chemically as well as mechanically and tend to split up the higher hydrocarbons molecules with increased yield of the more valuable lighter fractions. In some cases it may be advantageous to operate the different condensing or dephlegmating columns at progressively decreasing pressures, reducing valves b^3, b^4, etc., being provided. Also when a plurality of stills are used, in which the oil is successively treated, the temperature can be progressively raised, and different pressures can be maintained corresponding to the temperature in each apparatus. Since each of these vessels or stills may operate independently of the others, while still coöperating in the complete apparatus and process, a vacuum can be used with some of the stills in order to decrease the pressure therein, such decrease in pressure resulting in a larger difference in pressure between the oil in the boiler and the still into which the oil is expanded, and a greater tendency toward vaporization of the expanded oil. It will be understood also that a vacuum can be maintained through the stills and dephlegmators and the process as a whole carried out under a reduced pressure Suitable control valves 8 and 9 for pumps N and N′ are provided; also valves 3, 4, 5, 7, 8, and 10 whereby the flow of oil through the pipes may be regulated and also the pressures controlled.

From the foregoing description it will be seen that the process and apparatus of the present invention enable a simple and inex-

pensive separation of the crude oil to be effected, either to obtain therefrom a few fractions only, such as the fuel oil separated from the lighter hydrocarbons and the heavier illuminating oil, or to obtain a complete separation of the crude oil into all the desired fractions, the number of dephlegmators and condensers and preheaters being varied within rather large limits as may be desired, and suitable air condensers being used when desired for separating the lubricating oils into different fractions. It will also be seen that heating of the oil is effected at only one point and that the heat for the remaining operations is derived from the distilled oils themselves. The process is thus simple and inexpensive in operation, and readily adapted to the fractionation and separation of crude oils widely differing in properties. Variations and modifications can be made in the process and apparatus as described and illustrated without departing from the spirit and scope of the invention, as set forth in the following claims.

This invention has for its object to simplify as far as possible the process and the apparatus for the distillation purposes proper, and at the same time to design the apparatus in such a manner that the heat supplied to the quantity of the product to be distilled, can be recovered as far as possible for the distillation purpose itself and for the preliminary heating of the material, that is to say, in such a way that the greatest economy may be combined with the lowest possible cost of installation.

What I claim is:—

1. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil under pressure, and reducing the pressure of the oil and introducing such oil into the oil to be distilled, whereby such oil is vaporized upon reduction of pressure and the distillation thereby effected.

2. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil above its normal boiling point and at a pressure sufficient to maintain the oil in a liquid state, and reducing the pressure of the oil and introducing such oil into the oil to be distilled, whereby such oil is vaporized upon reduction of pressure and the distillation thereby effected.

3. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil of relatively high boiling point under pressure above its normal boiling point and reducing the pressure of the oil and introducing such oil into the oil to be distilled, whereby such oil is vaporized upon reduction of pressure and the distillation thereby effected.

4. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil under pressure, circulating such heated oil into heating relation with the oil to be distilled, and introducing part of the heated oil into the oil to be distilled with reduction of pressure.

5. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil of relatively high boiling point above its normal boiling point under pressure, circulating such heated oil into heating relation with the oil to be distilled and returning the same to be further heated and circulated, and introducing part of the heated oil into the oil to be distilled with reduction of pressure.

6. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil above its normal boiling point and at a pressure sufficient to maintain the same in a liquid state, circulating such heated oil into heating relation with the oil to be distilled, and introducing part of such heated oil into the oil to be distilled with reduction of pressure.

7. The process of distilling crude oil and other hydrocarbons which comprises preheating the oil to be distilled and introducing the same near the top of the still, heating a portion of such oil under pressure and circulating such heated oil into heating relation with the oil in such still.

8. The process of distilling crude oil and other hydrocarbons which comprises preheating the oil to be distilled and introducing the same near the top of the still, heating a portion of such oil under pressure and circulating such heated oil into heating relation with the oil in such still and introducing part of such heated oil into the still near its lower end with reduction of pressure.

9. The process of distilling crude oil and other hydrocarbons which comprises preheating the oil to be distilled and introducing the same near the top of the still, drawing off oil from the bottom of the said still and heating the same under pressure to above its normal boiling point, and introducing such heated oil into the oil in such still with reduction of pressure.

10. The process of distilling crude oil and other hydrocarbons which comprises preheating the oil to be distilled and introducing the same near the top of the still, drawing off oil from the bottom of said still and heating the same under pressure to above its normal boiling point, circulating such heated oil into heating relation to the oil within such still, and introducing part of the heated oil into the oil in such still with reduction of pressure.

11. The process of distilling crude oil which comprises preheating such oil and removing therefrom the more volatile fractions by subjecting the same to the heating

action of distillates resulting from the subsequent treatment, introducing the preheated oil freed from such more volatile fractions near the top of a still, drawing off from the still a part of the oil therein and heating the same under pressure, circulating such heated oil into heating relation with the oil in such still, and subjecting the crude oil to the heating action of the distillate from such still to effect the removal of the more volatile fractions therefrom.

12. The process of distilling crude oil which comprises preheating such oil and removing therefrom the more volatile fractions by subjecting the same to the heating action of distillates resulting from the subsequent treatment, introducing the preheated oil freed from such more volatile fractions near the top of a still, drawing off from the still a part of the oil therein and heating the same under pressure, introducing such heated oil into the oil in said still with reduction of pressure to effect distillation of the oil therein, and subjecting the crude oil to the heating action of the distillate from such still to effect the removal of the more volatile fractions therefrom.

13. The process of distilling crude oil which comprises preheating such oil and removing therefrom the more volatile fractions by subjecting the same to the heating action of distillates resulting from the subsequent treatment, introducing the preheated oil freed from such more volatile fractions near the top of a still, drawing off from the still a part of the oil therein and heating the same under pressure, circulating such heated oil into heating relation with the oil in such still, introducing part of such heated oil into the oil in said still with reduction of pressure, and subjecting the crude oil to the heating action of the distillate from such still to effect the removal of the more volatile fractions therefrom.

14. The process of distilling crude oil and other hydrocarbons which comprises preheating the oil to be distilled and introducing the same near the top of the still, baffling and spreading out such oil in its passage down through said still, drawing off from the bottom of such still a portion of the oil and heating the same under pressure to above its normal boiling point, circulating the heated oil into heating relation with the oil in such still while baffled and spread out therein, and introducing part of such heated oil with reduction of pressure into the oil in the bottom of said still.

15. The process of distilling crude oil which comprises preheating such oil and removing therefrom the more volatile fractions by subjecting the same successively to the heating action of distillates of progressively lower boiling point resulting from the subsequent treatment of such oil, introducing the preheated oil freed from such more volatile fractions near the top of a still, drawing off from the bottom of the still a part of the oil therein and heating the same under pressure, introducing part of the heated oil into the oil in the bottom of such a still with reduction of pressure, and thereby vaporizing part of the same and of the oil in such still, circulating part of such heated oil into heating relation with the liquid flowing down through said still and the vapors rising therein, and subjecting the crude oil flowing to said still in successive stages to the action of the distillate from such still to effect removal of the more volatile fractions therefrom.

16. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, means for introducing part of the oil from said still into said boiler under pressure, and means including a pressure reducing valve for introducing the heated oil from said boiler into said still.

17. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, means for introducing part of the oil from said still into said boiler under pressure, means including a pressure reducing valve for introducing the heated oil from said boiler into said still, and means for circulating part of said heated oil through said still to heat and distil the oil therein.

18. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, means for introducing part of the oil from said still into said boiler under pressure, means including a pressure reducing valve for introducing the heated oil from said boiler into said still, intermediate perforated partitions within said still forming chambers therebetween, heating coils in said chambers between said partitions and means for circulating heated oil from said boiler through said coils.

19. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, means for introducing oil from said still into said boiler under pressure, means including a heating coil for circulating the heated oil under pressure within said still, and a pipe connection from said coil to said still having a regulable pressure reducing valve therein for the introduction of said heated oil into said still at a lower pressure.

20. A distilling apparatus comprising a

still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, a pump connected with the bottom of said still and said boiler for feeding oil to said boiler and regulating the pressure therein, a heating coil connected to the boiler and arranged in said still for the circulation therethrough of heated oil, means including a pressure reducing valve connecting said heating coil with the bottom of the boiler for the introduction of the heated oil into said still at a lower pressure, and a pump for effecting circulation from said boiler through said heating coil.

21. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, means for maintaining said still under pressure, a boiler for heating oil under a pressure greater than that of said still, means for introducing oil from said still into said boiler under pressure, means including a heating coil for circulating the heated oil under pressure within said still, and a pipe connection from said coil to said still having a regulable pressure reducing valve therein for the introduction of said heated oil into said still at a lower pressure.

22. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, a boiler for heating oil under pressure, means for introducing part of the oil from said still into said boiler under pressure, means including a pressure reducing valve for introducing the heated oil from said boiler into said still, means for circulating part of said heated oil through said still to heat and distill the oil therein, and means for preheating the oil flowing into said still by the distillate therefrom.

23. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, intermediate perforated partitions within said still forming chambers therebetween, heating coils in said chambers between said partitions for the heating medium, a dephlegmator for subjecting the oil flowing to said still to the heating action of the distillate therefrom, a return pipe from the bottom of said dephlegmator to said still, a second dephlegmator for subjecting the oil flowing to said first dephlegmator to the heating action of the vapors from said dephlegmator, and a return pipe from said second dephlegmator to one of the chambers of said still.

24. A distilling apparatus comprising a still provided with an inlet for the oil to be distilled and an outlet for the distillate therefrom, means for heating said still, a series of dephlegmators arranged to condense successive fractions of the distillate of progressively lower boiling points, means for circulating the oil through said dephlegmators in the reverse direction before reaching the still, and means for subjecting the oil to the heating action of the still residue before it reaches the dephlegmators.

25. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil under pressure, reducing the pressure of the oil and introducing such oil into the oil to be distilled, and commingling heated water vapor with the oil being distilled, whereby such oil is vaporized upon reduction of pressure and distillation is effected in the presence of water vapor.

26. The process of distilling crude oil and other hydrocarbons which comprises heating a portion of the oil under pressure, reducing the pressure of the oil and introducing such oil into the oil to be distilled, whereby such oil is vaporized upon reduction of pressure and the distillation thereby effected, reheating the undistilled residue and treating it as specified above.

27. A process of treating hydrocarbon oils which consists in heating such an oil under pressure and in a closed and substantially filled chamber under cracking conditions, followed by quick reduction of pressure of such oil and introduction of the pressure reduced oil, or the vapors resulting from such pressure reduction, into another body of oil with resultant imparting of latent heat to the second body of oil and the distillation thereof.

28. A process of treating hydrocarbon oils which consists in heating such an oil under pressure and in a closed and substantially filled chamber under cracking conditions, followed by quick reduction of pressure of such oil and introduction of the pressure reduced oil, or the vapors resulting from such pressure reduction, into another body of oil with resultant imparting of latent heat to the second body of oil and the distillation thereof, and collecting and fractionating the resulting vapors.

In testimony whereof I have signed this specification in the presence of two subscribing witnesses.

ALBRECHT FRIEDRICH GEORG
PAIL JOSEF VON GROELING.

Witnesses:
CLYDE A. KING,
H. R. HEAL.

3330

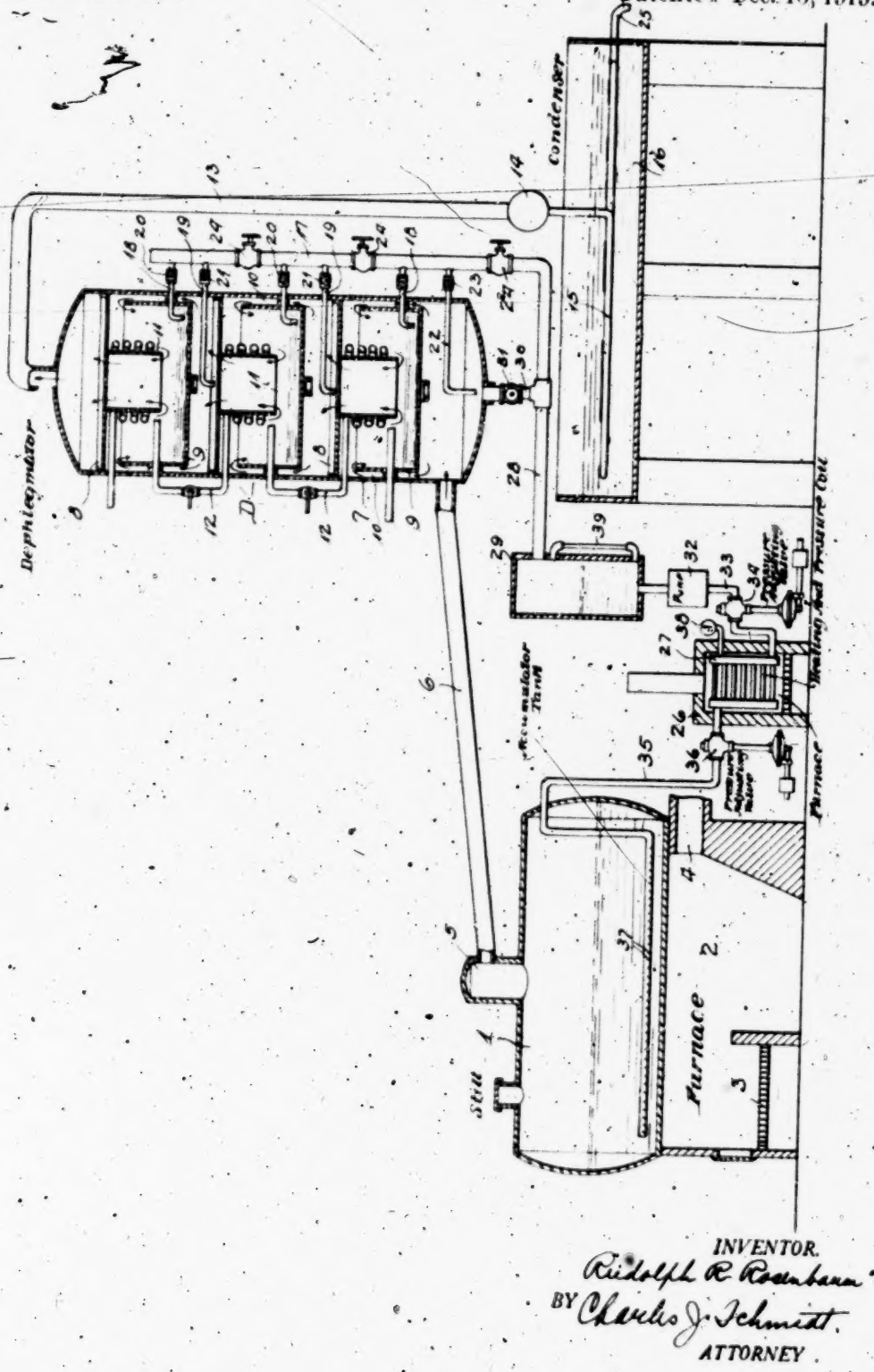
R. R. ROSENBAUM.

PROCESS AND APPARATUS FOR TREATING HYDROCARBONS.

APPLICATION FILED OCT. 3, 1917.

1,324,983.

Patented Dec. 16, 1919.



INVENTOR.
Rudolph R. Rosenbaum
BY Charles J. Schmidt
ATTORNEY.

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UNITED STATES PATENT OFFICE.

RUDOLPH R. ROSENBAUM, OF CHICAGO, ILLINOIS.

PROCESS AND APPARATUS FOR TREATING HYDROCARBONS.

1,324,983. Specification of Letters Patent. Patented Dec. 16, 1919.

Application filed October 3, 1917. Serial No. 194,439.

To all whom it may concern:

Be it known that I, RUDOLPH R. ROSENBAUM, a citizen of the United States, and a resident of Chicago, in the county of Cook and State of Illinois, have invented certain new and useful Improvements in Processes and Apparatus for Treating Hydrocarbons, of which the following is a specification.

My invention relates to an improved process and apparatus for treating hydrocarbons and its object is to obtain a greater percentage of a desired low boiling hydrocarbon from a given quantity of crude oil or petroleum than has heretofore been possible. It is well known practice to secure and separate the various hydrocarbons by the distillation of petroleum, the various hydrocarbons being driven off at different stages of temperature according to their respective boiling points, the various hydrocarbons being separated and condensed by the process of fractional condensation. In this distillation and condensation process of the prior art the percentage of low boiling hydrocarbons obtained is relatively small.

The main object of my invention is to provide a process or treatment which will crack or break up the heavier hydrocarbons to thereby effect the release of lower hydrocarbons. The important feature of my improved process is the utilization of kinetic heat energy for cracking or breaking up of the heavier hydrocarbons. In accordance with my process I heat the hydrocarbons in their liquid state considerably above their normal boiling temperature, such heating being under comparatively heavy pressure so that a large amount of kinetic heat energy is stored, the highly heated liquid resulting from such superheating being discharged into low pressure surroundings to be expanded into vapors whereupon the released kinetic heat energy becomes effective to break up the heavier hydrocarbon vapors into lighter vapors. These vapors can then be separated and condensed. The petroleum oil can be directly subjected to this superheating under pressure, or the oil can first be run through the ordinary distilling and dephlegmation process, and then all or part of the condensates either together or separately subjected to the breaking process. Where my breaking up process is used in connection with a still and dephlegmator the condensates are pumped from the dephlegmator and subjected to superheating under pressure and discharged into the still, the liberated kinetic heat energy then breaking up the resulting vapors and also acting on any oil within the still to highly heat it and break up the heavier hydrocarbons into lighter hydrocarbons. The resulting vapors are then delivered from the still to the dephlegmator for further fractional condensation.

On the accompanying drawing the figure diagrammatically illustrates simple apparatus for carrying out my improved process.

A still 1 is mounted over a furnace 2 having the grate 3 and the flue or stack 4. D represents a dephlegmator such as is disclosed in my Patent No. 1,222,801, April 17, 1917, although other types of dephlegmators may be utilized. The dome 5 of the still is connected by the pipe 6 with the lower end of the drum 7 of the dephlegmator. This drum is vertically divided by the horizontal partitions 8, there being a pan 9 below each partition separated from the drum by an annular space 10. From the center of each partition a tube 11 extends downwardly into the pan below, the partitions above the tubes being reticulated. A piping circuit 12 for cooling fluid encircles the various tubes 11. From the top of the drum a pipe 13 extends downwardly to a header 14 with which header the pipe coil 15 connects and is immersed in cooling fluid within the condenser tank 16. The stand-pipe 17 alongside of the drum connects by pipes 18 with the various pans, and pipes 19 extend from the stand-pipe to the reticulated portions of the partitions. Each pipe 18 is controlled by a valve 20 and each pipe 19 is controlled by a valve 21. A pipe 22 also extends from the stand-pipe to the bottom of the drum and is controlled by a valve 23. The stand-pipe has also several valves 24 for opening or closing various sections of the pipe.

The operation of the still and dephlegmator is well understood in the art. The vapors from the still pass into the bottom of the dephlegmator drum and circulate serially through the drum as indicated by the arrows, the fractional condensation taking place as the vapors meet cooler temperatures in their upward travel in the drum. The vapors of highest boiling point condense first, the vapors of low boiling point which are not condensed passing through pipe 13 into the header 14 and thence through the condenser 15, the condensed vapors being dis-

charged from the outlet 25. The various condensates within the drum are collected in the pans 19, and, as disclosed in my patent above referred to, these condensates can be discharged from one pan into the other by manipulation of the various valves or they can be separately withdrawn from the dephlegmator. In some prior processes some or all of the condensates are returned to the still and are re-heated and then vapors again passed through the dephlegmator for further separation. However, such treatment does not result in a very great increase in percentage of lighter hydrocarbons and a considerable amount of such higher hydrocarbons is therefore not obtained.

In accordance with my present process I provide apparatus for highly heating the condensates under pressure and cause generated kinetic heat energy to break up the heavier hydrocarbons so that a large percentage of lighter hydrocarbons are liberated which are then separated in the dephlegmator. The apparatus shown comprises a suitable furnace 26 within which is a coil 27 in which the condensates are heated. The stand-pipe 17 is connected by a pipe 28 with an accumulator tank 29, the pipe 30 connecting the bottom of the drum with this pipe 28, the valve 31 being interposed. The lower end of the accumulator connects with a high pressure pump 32, the outlet of the pump being connected by pipe 33 with one end of the heating coil 27. In this pipe 33 is interposed a pressure valve 34 whose construction is well understood in the art. From the other end of the heating coil a pipe 35 leads to the still 1 and in this pipe is interposed another pressure valve 36. The pipe 35 extends along the bottom of the still where it has the outlet openings 37. The pressure valves are relatively adjusted so that the condensate is under the desired pressure while being heated in the coil 27, a gage 38 being preferably provided on the coil to indicate the pressure thereon. The gage 39 is also shown on the accumulator tank 29 to indicate the amount of condensate therein.

Describing now the operation, the crude oil is poured into the still and heated, the driven off vapors flowing to the dephlegmator where they are condensed, the heavier hydrocarbons being collected in the bottom of the drum and in the various pans, while the lighter hydrocarbon vapors, such as gasolene, flow through the pipe 13 to be condensed in the coil 15. Thus far only a part of the available gasolene has been obtained from the crude oil, the various condensates in the dephlegmator still retaining some of the lighter hydrocarbons. If the valve 31 is open the condensate at the bottom of the drum flows through pipe 28 into the accumulator tank and as soon as the condensates in the various pans rise above the levels of the pipes 18 they will flow through the piping 17 and 28 into the accumulator tank if the valves 20 are open. These valves can remain open while distillation is going on or can be closed during that period and opened when desired so that when the pump 32 is started these condensates will be sucked from the dephlegmator and forced through the heating coil 27 where they are heated under the pressure determined by the setting of the pressure valves.

As an example to illustrate the efficiency of my method, suppose that a quantity of crude oil is distilled and treated in the ordinary manner. Suppose that the oil is of 34.2 Bé, and that it is heated in the tank beginning with a temperature of say 100 degrees F. and the temperature then increased during the distillation operation to from 480 degrees to 510 degrees. The following results and products might be obtained:

18%	of gasolene	of from	60 to 61	gravity
8%	" naphtha	" "	48 to 50	"
19%	" kerosene	" "	42 to 43	"
2%	Loss			

47% total yield and leaving
53% petroleum tailings.

If now, the said oil had been subjected to my improved process, under a temperature of 500 degrees to 850 degrees F. and pressure increasing from say 50 to 200 pounds per square inch, the following result would be obtained:

27%	of gasolene	of from	60 to 61	gravity.
14%	" naphtha	" "	48 to 50	"
7%	" kerosene	" "	42 to 43	"
5%	Loss			

53% total yield and leaving
47% petroleum tailings.

The decided increase in the yield of gasolene and naphtha results from the cracking up of the vapors when suddenly expanded in the still after the condensates from the dephlegmator have been subjected to unusual heat and pressure.

The process of superheating condensates under pressure can be repeated several times until there is no further yield of the particular hydrocarbon desired. Instead of running all the condensates together through the superheater, only part thereof can be thus treated. For example, the condensate in the upper pan of the dephlegmator can be treated separately by manipulating the various valves and drawing this condensate into the accumulator tank and pumping it through the superheater.

I thus produce a method, system, and apparatus by means of which any desired hydrocarbon of a certain boiling point can be obtained in greatly increased quantity

from a given quantity of crude oil or a hydrocarbon of a higher boiling point. By associating simple superheating and pressure producing mechanism with the ordinary still-dephlegmator system all or part of the dephlegmator condensates either together or separately can be heated under pressure and the still utilized as an expansion chamber, the released kinetic energy acting on the generated vapors and also on any oil in the still to break up the heavier hydrocarbons into lighter hydrocarbons, and then when the vapors from the still are again passed through the dephlegmator a quantity of any desired hydrocarbon can be obtained in addition to that resulting from the first passage of the crude oil vapors from the still through the dephlegmator.

I do not of course desire to be limited to the exact procedure and apparatus shown and described as modifications are no doubt possible which would still come within the scope of the invention.

I claim as follows:

1. The process of treating hydrocarbon oil which comprises distilling it, dephlegmating the resulting vapors and removing the vapors of hydrocarbons of the desired boiling point, subjecting the dephlegmated condensates of higher boiling point to sufficient pressure and at a temperature above the normal boiling point to cause kinetic heat energy to be stored in the condensates, discharging the heated and compressed condensates into lower pressure surrounding for expansion thereof into vapors and to permit the released kinetic heat energy to break up the vapors to form vapor of the hydrocarbon of the desired boiling point, and dephlegmating the resulting vapors to obtain an additional supply of condensate of the hydrocarbon of the desired boiling point.

2. The process of obtaining a lighter hydrocarbon from a cruder hydrocarbon which consists in subjecting the cruder hydrocarbon to heat in a still, fractionally condensing the resulting vapors and removing the vapors of the obtained lighter hydrocarbon, subjecting the remaining heavier condensate to superheating under sufficient pressure to store kinetic heat energy therein, then discharging the condensate into the bottom of the still for expansion thereof into vapor to permit the liberated kinetic heat energy to break up such vapors and any oil in the still to liberate additional lighter hydrocarbon, and fractionally condensing the resulting still vapors and removing the lighter hydrocarbon condensate.

3. In a system for treating hydrocarbon oil, the combination of a still, condensing apparatus for fractionally condensing the still vapors, superheating mechanism, a pump for pumping condensates from the condensing mechanism to the heating mechanism, means for subjecting said condensates to pressure during heating thereof, and a connection from said heater into the still, such heating of the condensates and the pressure being sufficient to cause the storing of kinetic heat energy therein which heat energy is liberated in the still to break up heavier hydrocarbons into lighter hydrocarbons.

4. In a system for treating hydrocarbon oil, the combination of a still, condensing apparatus for fractionally condensing the still vapors, means for returning condensates from the condensing apparatus to the still, and means for subjecting the condensates to sufficient pressure and heat above the normal boiling point before the condensates reach the still to cause kinetic heat energy to be stored in the condensates to be released upon expansion of the condensates when discharged into the still, such kinetic heat energy breaking up the heavier hydrocarbon into lighter hydrocarbon.

In witness whereof I hereunto subscribe my name this 28th day of September, A. D. 1917.

RUDOLPH R. ROSENBAUM.

DISCLAIMER

1,324,983.—*Rudolph R. Rosenbaum*, Chicago, Ill. PROCESS AND APPARATUS FOR TREATING HYDROCARBONS. Patent dated December 16, 1919. Disclaimer filed October 8, 1932, by the assignee, *Gasoline Products Company, Inc.*

Hereby enters this disclaimer to the subject matter of the claims thereof except as they apply to a process and apparatus in which the condensates are heated separately from the cruder hydrocarbon charge undergoing distillation and are then brought into contact therewith.

[*Official Gazette November 1, 1932.*]

3336

P. McD. BIDDISON AND H. T. BOYD.

PROCESS OF DISTILLING PETROLEUM.

APPLICATION FILED FEB. 15, 1918.

1,345,740.

Patented July 6, 1920.

2 SHEETS—SHEET 1.

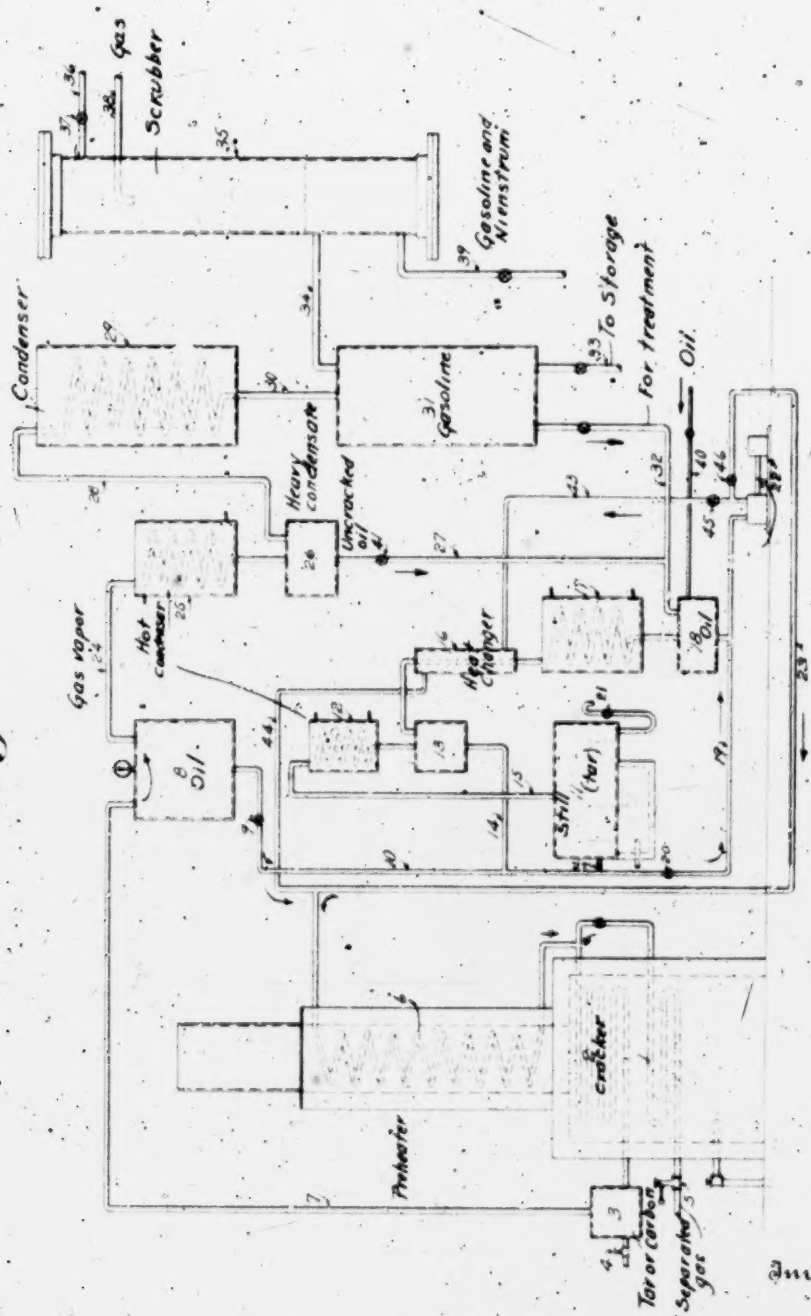

Fig. 1.

Inventors:

P. McDonald Biddison,

Hugh T. Boyd,

By Speer Middleton, Donaldson & Speer

Attorneys

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P. McD. BIDDISON AND H. T. BOYD.

PROCESS OF DISTILLING PETROLEUM.

APPLICATION FILED FEB. 15, 1918.

1,345,740. Patented July 6, 1920.

2 SHEETS—SHEET 2.

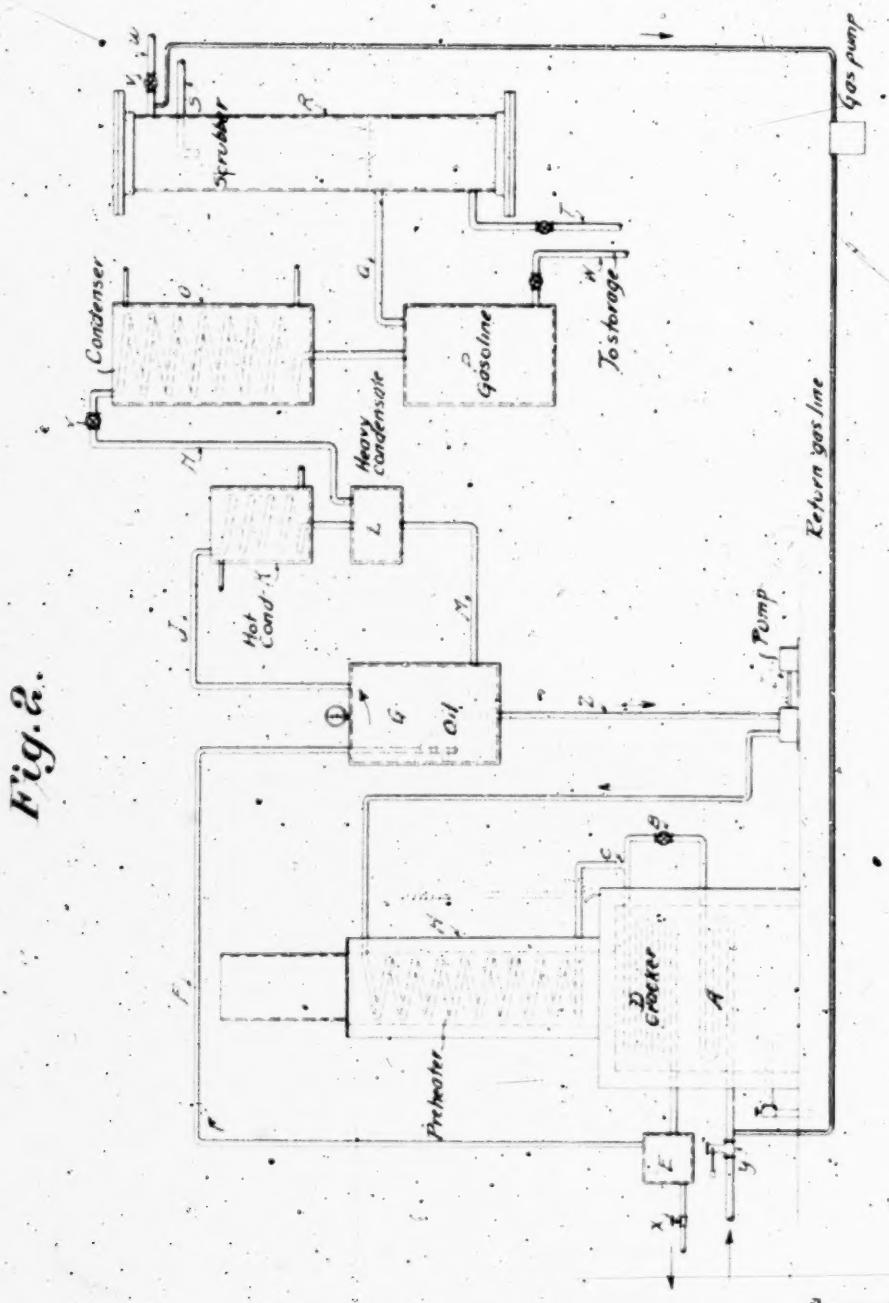


Fig. 2.

Inventors:
P. McDonald Biddison,
Hugh T. Boyd,
By Spear, Middleton, Donaldson & Spear
Attorneys.

UNITED STATES PATENT OFFICE.

PASCAL McDONALD BIDDISON, OF COLUMBUS, AND HUGH T. BOYD, OF HOMER, OHIO.

PROCESS OF DISTILLING PETROLEUM.

1,345,740. Specification of Letters Patent. Patented July 6, 1920.

Application filed February 15, 1918. Serial No. 217,440.

To all whom it may concern:

Be it known that we, PASCAL McDONALD BIDDISON and HUGH T. BOYD, of Columbus and Homer, Ohio, respectively, have invented certain new and useful Improvements in Processes of Distilling Petroleum, of which the following is a specification.

Our invention has to do with an improvement in the distillation or treatment of petroleum particularly for obtaining therefrom low-boiling point hydrocarbons from higher boiling point hydrocarbons.

In the art of distilling residue of petroleum distillation such as gas oil or fuel oil at atmospheric pressure, vaporization begins at upward of 450° F. and all will distil over at temperature upward of 650° F. In distilling this residue under a pressure upward of 3 atmospheres, a range of temperature of about 650°–850° F. is produced.

There are many objectionable features in the present processes of distilling petroleum residues for the production of low-boiling-point hydrocarbons; first, the danger of the still bottom burning out under the excessive heat required on the outside of the oil containing wall in order to attain a "cracking" temperature on the oil within and the subsequent discharge of a large volume of oil into the furnace, second, the difficulty of maintaining a constant temperature due to carbon depositing on the walls of the still and insulating them, third, the difficulty of maintaining a constant pressure on the system, fourth, the difficulty of maintaining a constant rate of distillation, fifth, the difficulty of removing carbon continuously from the system, sixth, the low percentage of high boiling hydrocarbons converted to low boiling point hydrocarbons.

The object of our process is to provide a method whereby these difficulties are reduced to a minimum in the distillation of petroleum residue for the production of low-boiling-point hydrocarbons. This is secured in our process by, first, the fact that excessive heat is not required on the walls of the still which is attained by keeping the temperature of the superheated gas high enough so that it, in connection with the lower heat on the oil-container walls, causes most of the decomposition to the lower-boiling-point hydrocarbons; second, the maintenance of a steady temperature control by regulation of the flow of gas through the superheater; third, the maintennance of very constant pressure by a regulating pressure valve on the gas inlet or outlet; fourth, the continuous removal of carbon by distillation from the cracked oil by means of intermediate stills so arranged that they can be used intermittently for removal of carbon and tar when it accumulates in quantity or can be used for the continuous removal of same, fifth, the maintenance of a steady rate of distillation by the gas flow.

By circulating oil at a fairly rapid rate, through the retort thus increasing the rate of heat transfer from the walls of the oil containing vessel we reduce the temperature required to be maintained on the walls of the oil containing vessel.

By agitation of the oil due to the rapid circulation and the injection of gas we prevent overheating of the molecules of the oil when they come in contact with the walls of the oil container.

It is admitted by numerous experimenters on oil-cracking processes that to produce gasolene containing only a low percentage of unsaturated hydrocarbons of the olefin series, that the low-boiling-point hydrocarbons must be removed from the reaction zone as soon as formed. We reduce the formation of unsaturated hydrocarbons of the olefin series by the removal of the low-boiling-point hydrocarbons from the liquid at the instant of formation by means of the injection of large amounts of superheated gas, which passing through the oil immediately saturates itself with the low-boiling hydrocarbons, removes them from the liquid and thus largely prevents the undue further cracking of these hydrocarbons to olefins.

We have found from our experimental work that the use of a gaseous medium as used in our method, involving the law of partial pressures, is of great value in reducing the percentage of un-saturated hydrocarbons of the olefin series. Without using the gaseous medium, our resulting gasolene contained almost double the percentage of olefin hydrocarbons. We attribute the difference in results to the low partial pressure of the oil vapors while in the process of decomposition at relatively high temperatures.

In our process only a portion of the oil in the cracking zone is in the vapor state. These vapors from the oil are mixed with

the superheated gas that has been admitted into the cracking zone. The pressure of these oil vapors then depends upon the proportion they form of the total vapors present according to the physical law of partial pressures of mixed gases and vapors. If the pressure in the cracking zone is 100 pounds absolute, and the oil vapors constitute one per cent. of the total vapors present, then the pressure of the oil vapors is one per cent. of 100 pounds or one pound, and the pressure of any one constituent of the oil vapors depends in like manner upon its proportion of the whole amount of vapors present. Our experiments and study have convinced us that while heat is necessary to break up the heavy oil into compounds of lower specific gravity, that pressure on the cracking vapors aids the formation of unsaturated compounds and retards the breaking up of the heavy hydrocarbons. In the system which we outline in this application we can get the temperature required for breaking up the heavy compounds while still maintaining a low pressure on the oil vapors. This actually results in an increased yield of gasolene containing a very low per cent. of unsaturated hydrocarbons. At the same time this injected gas serves the very valuable purpose of removing from the liquid the gasolene as quickly as formed.

In our experiments we have used natural gas containing about 80% methane and 15% ethane by ordinary combustion analysis but we do not restrict ourselves to the use of this gas but intend to cover other gases, either natural gas of any composition, coal gas, water gas, hydrogen, nitrogen or any hydrocarbon gas or any other gas which will not produce combustion in the retort and which has the power of saturating itself with oil vapors, preferably a hydrocarbon gas in which substances belonging to the paraffin series predominate. For instance the gas generated in the cracking process can itself be compressed and re-circulated.

In the accompanying drawing, Figure 1, illustrates diagrammatically one form of apparatus comprising a so-called pressure still. Fig. 2, is a diagram showing the apparatus without intermediate tar stills.

At 8 and 18 are shown tanks containing the oil being treated. From near the bottom of the tank 8 an outlet line 10 leads to either continuous still 11, or to tank 18 by valve 20 and line 19. From tank 18 the fresh oil is circulated by pump 22 through line 23 to a preheating coil 6 where it is preheated before entering the "cracking" zone at 2. At a point outside of 2 superheated gas enters through regulator valve 5 and coil 1. The gas-oil mixture passes out of cracking zone 2 into a small receiver 3 where any accumulated carbon can be blown out by way of valve 4. From 3 the gas-oil mixture passes by line 7 back to storage tank 8. From tank 8 the gas saturated with light and heavy hydrocarbons passes to a hot condenser 25 where by proper temperature regulation all heavy or "uncracked" oil can be returned from 26 and outlet line 27 back through tank 18 to the circulating pump 22. From 26 the gas and light hydrocarbons pass by line 28 to cold condenser 29 where most of the light low-boiling-point hydrocarbons condense and pass by line 30 receiver 31. They can be drawn off here by line 33 and sent to gasolene storage tanks by line 33 or sent back into circulation if not of high enough gravity (Bé.) or in other words, of too high boiling point, in exceptional cases through line 32. From receiver 31 the gas passes by 34 to any suitable scrubber or absorber 35 where the gas is scrubbed of any remaining gasolene vapors by an absorbent menstruum entering at 38 and passing out at 39. Heavy oil may be used as the absorbent in 35. The denuded gas passes out of the system by valve 37 and line 36. Fresh oil can be fed into the cracking system by line 40. When, after considerable use the system accumulates some tarry matter, valve 20 may be closed and valve 42 opened. Then the oil from 8 passes to still 11. From 11 the distillate vapors pass by 15 to hot condenser 12 where any tarry matter carried mechanically by the vapors is knocked out into 13 and which tarry matter passes back to still 11 by line 14. The clean oil vapors pass through heat exchanger 16 to condenser 17 where they are liquefied and pass back into the system through receiver 18 and circulating pump 22 by either valve 46 and line 23 or valve 45 and line 43 and 44, in the latter case passing through heat exchanger 16.

Thus three systems of operation are available:

A system of operation where oil from tank 8 passes directly to pump 22 through line 10 valve 20 and pipe 19 thence back through line 23 to cracking zone, the oil in tank 8 gradually diminishing in volume due to the products passing off at line 24, while still 11 is used intermittently for the removal of tarry matter and carbon by closing valve 20 and allowing oil to pass through still 11 condenser 12, separator 13, exchanger 16, condenser 17, tank 18, pump 22, thence back to cracking zone through valve 45 line 43 exchanger 16 and pipe 44, valve 40 being closed and no fresh oil being admitted during this system of operation.

Or, the same system as above may be followed except that the oil level in tank 8 is maintained at practically a constant level by means of either continuous or intermittent admission of oil through line 40. The tank 8 is filled by closing valves 41, 20 and 9, and the valve in line 32 opening valve 40

and starting pump 22 with either valve 45 or 46 open, the oil in each case passing through coil 2 and pipe 7 into tank 8.

Or a system of operation may be followed where the oil level in tank 8 is maintained at practically a constant level by means of either continuous or intermittent admission of oil through line 40 and the still 11 is used continuously for the removal of tarry matter and carbon by passing the oil from tank 8 through valve 42 into still 11, thence through condenser 12, separator 13, exchanger 16, condenser 17, tank 18 and pump 22 thence back to cracking zone through pipe 43, exchanger 16 and pipe 44.

The following is a description of our process such as would enable any one skilled in the art to which it pertains, to use and apply the same.

Oil to be distilled is fed into the system through line 40 and pump 22 until a sufficient charge is accumulated in tank 8. Then with valves 37, 41, 42, and 9 closed, as well as the valves in pipes 32 and 33, the system is filled with gas through regulator 5 and coil 1. Heating of the furnace is started and oil is started in circulation by pump 22. The regulating valve 5 is set for the desired pressure and when the coil at 2 approaches the desired temperature and the superheated gas is considerably above the desired cracking temperature, distillation is started by partly opening the outlet valve 37 with absorbent oil circulating through absorber 35, the gas plus hydrocarbons pass from tank 8 through line 24 to hot condenser 25 where heavy hydrocarbons condense into receiver 26 and are let back into the system by valve 41 and line 27. The gas plus low-boiling hydrocarbons pass to a cold condenser 29 by means of line 28 where the most of the gasolene condenses and falls into receiver 31. The gas, still containing some light hydrocarbons, passes by line 34 to absorber 35 where it is denuded of its gasolene vapors by absorbent oil entering at 38 and passing out at 39, to a suitable distilling apparatus where the gasolene is distilled off from the absorbent oil, the absorbent oil cooled and returned to scrubber by line 38. The denuded gas passes out of system by line 36.

After the system has been in use for a considerable length of time, tarry matter accumulates to a slight extent, and this is removed as heretofore described.

Referring to Fig. 2, G is an oil storage tank with an outlet pipe line Z leading to force pump I which forces oil through heat exchanger coil in H down into still D, which serves as a cracking coil. At point C outside the pressure still D superheated gas enters from gas superheater A. The superheated gas plus oil mixture after passing through pressure still D comes out into small receiver E where any accumulated carbon can be occasionally blown out by the valve X. The gas oil mixture passes by line F to reservoir G and the condensate passes around the system again. The gas and uncondensed vapors pass to hot condenser K where heavy hydrocarbons are condensed into receiver L and pass back to reservoir G through M. The gas saturated with light hydrocarbon vapors, passes to condenser O, still under the pressure maintained in D and G, through line N where the main low boiling condensate is obtained in receiver P with outlet W. The gas before passing back into the gas mains is pr ssed through line Q to absorber R where the last valuable portions of gasolene are removed by an absorbent menstruum entering at S and exiting at T. The oil drawn off at T may be treated in any suitable still to separate the absorbed gasolene from the absorbent menstruum. The denuded gas passes out through valve V and line U.

By means of the auxiliary condenser K the heavier hydrocarbons are knocked out of the gaseous mixture, into receiver L and the regulation of this condenser properly, permits of drawing off gasolene direct from the main condenser through tank P and line W, without redistillation.

When desired the gas from the outlet of the absorber can be returned by a suitable gas pump or compressor to the gas superheater in which case the gas regulator valve is preferably located on the outlet gas line of absorbers.

What we claim as new and desire to secure by Letters Patent, is;

1. That process in the art of distilling liquid residues of petroleum distillation having a boiling point of upward of 400° F. for the obtaining of low-boiling-point hydrocarbons, which consists in circulating the oil from and back to a bulk supply of the liquid; maintaining on the oil a pressure which prevents fractional distillation, not less than the pressure under which the vapors are condensed, by means of injected highly heated gas; continuing the cracking and starting distillation by causing highly heated gas to flow through the cracking zone, cooling the gases and vapors in an auxiliary condenser sufficient to condense oils less volatile than the desired product; further cooling the gas and vapors in the main condenser; absorbing the last traces of gasolene from the gas in an absorber by means of an absorption menstruum, as described.

2. That process in the art of distilling liquid residues of petroleum distillation having a boiling point of upward of 400° F. for the obtaining of low-boiling-point hydrocarbons, which consists in circulating the oil from and back to a bulk supply of the liq-

uid; maintaining on the oil a pressure which prevents fractional distillation, equal to or greater than the pressure under which the vapors are condensed, by means of injected highly heated gas; continuing the cracking and starting distillation by causing highly heated gas to flow through cracking zone, passing the gases and vapors through an auxiliary condenser, bringing back to the bulk supply of the oil any liquid condensed by the auxiliary condenser; cooling the gas and vapors in the main condenser under a pressure about equal to the pressure on the oil during distillation; absorbing the last traces of gasolene from the gas in an absorber by means of an absorbent menstruum; removing from the system tarry matter from the bulk supply of the liquid by distillation while maintaining a constant amount of oil in the system by addition of new oil.

3. That process in the art of distilling petroleum residues having a boiling point of upward of 400° F. for the production of lower boiling point hydrocarbons, which consists in circulating the oil from and back to a bulk supply of the liquid while maintaining on the oil a pressure which prevents fractional distillation not substantially less than the pressure under which the vapors are condensed by means of highly heated gas; continuing the cracking and distillation by causing highly heated gas to flow through the cracking zone; passing the gases and vapors through an auxiliary condenser, bringing back to the bulk supply of the oil any liquid condensed by the auxiliary condenser, cooling the gas and vapor in the main condenser and absorbing the last traces of gasolene in any suitable absorber by the way of means of a suitable absorption menstruum.

4. The improvement in the art of cracking mineral oil having a boiling point above that of ordinary gasolene, which comprises maintaining a bulk of oil under superatmospheric pressure, passing oil from such bulk together with a highly heated gaseous fluid containing hydrocarbons, through a coil in which the oil is heated to a cracking temperature, while under superatmospheric pressure, thereafter passing the resulting product through a trap to remove non-vaporous material, then cooling the gases and vapors sufficiently, while under said pressure to separate products not sufficiently volatile for gasolene substitute, then further cooling such gases and vapors sufficiently to condense gasolene, all of said operations being conducted under superatmospheric pressure, and finally scrubbing the remaining gases with an absorbent for gasolene vapors.

In testimony whereof we affix our signatures.

P. McDONALD BIDDISON.
HUGH T. BOYD.

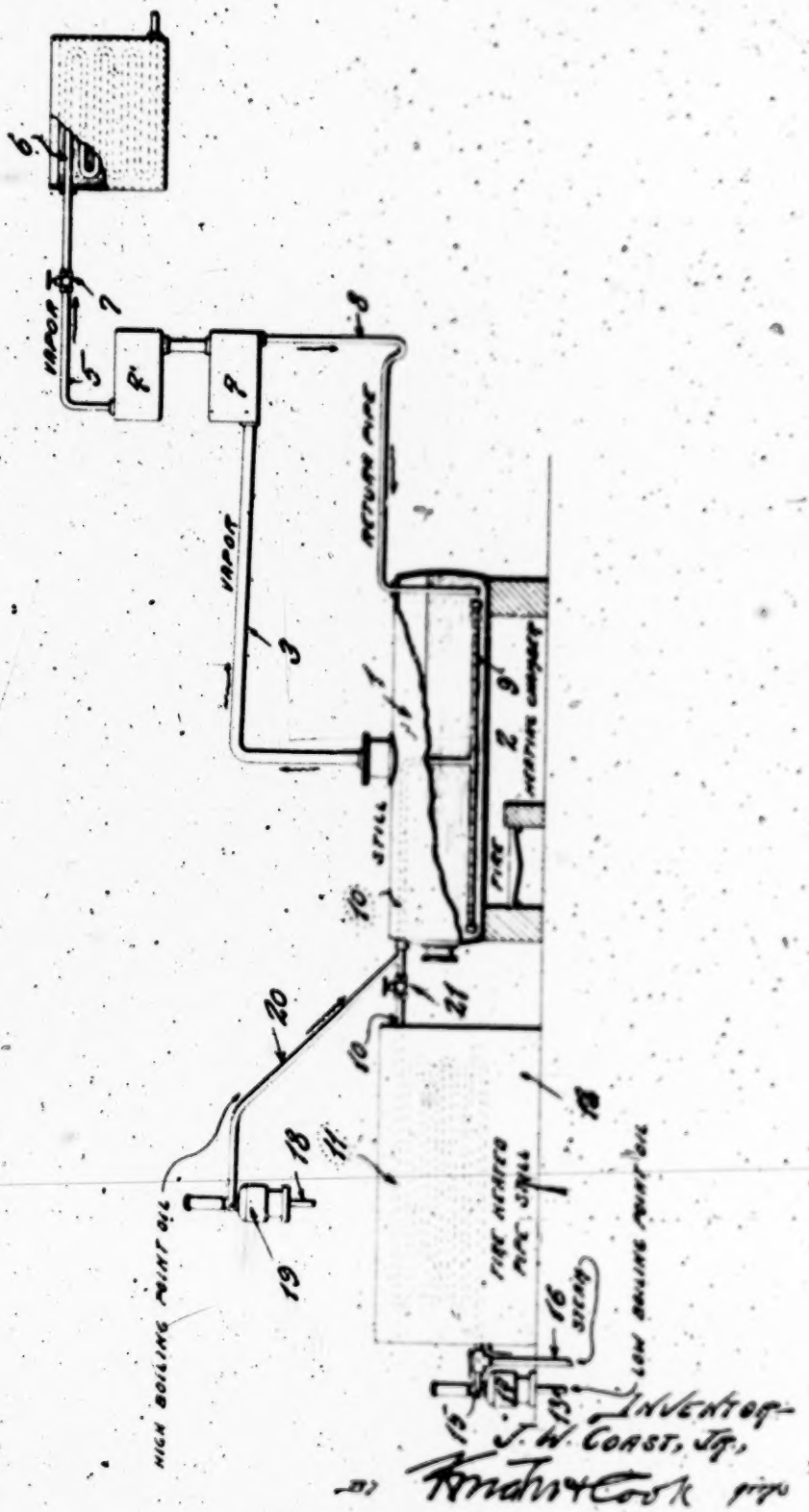
3344

J. W. COAST, Jr.

ART OF CRACKING HYDROCARBONS.

APPLICATION FILED SEPT 27, 1917.

1,388,629. Patented Aug. 23, 1921.



INVENTOR
J. W. COAST, JR.
BY Knight Cook
ATTY

UNITED STATES PATENT OFFICE.

JOHN W. COAST, JR., OF TULSA, OKLAHOMA, ASSIGNOR TO THE PROCESS COMPANY, OF TULSA, OKLAHOMA, A CORPORATION OF MARYLAND.

ART OF CRACKING HYDROCARBONS.

1,388,629. Specification of Letters Patent. Patented Aug. 23, 1921.

Application filed September 27, 1917. Serial No. 193,472.

To all whom it may concern:

Be it known that I, JOHN W. COAST, JR., a citizen of the United States of America, a resident of Tulsa, in the county of Tulsa, State of Oklahoma, have invented certain new and useful Improvements in the Art of Cracking Hydrocarbons, of which the following is a full, clear, and exact description, reference being had to the accompanying drawing, forming a part of this specification.

This invention relates to improvements in the art of cracking hydrocarbons, and more particularly to a method of treating petroleum hydrocarbons to obtain a product known as gasolene, cracked gasolene and by other names designating an explosive oil suitable for use in internal combustion engines. Some of the objects of the invention are to avoid the danger, expense and loss of time usually due to the presence of coke-forming matter in cracking stills; to economize in the use of fuel, and to utilize the hot fluid discharged from a cracking coil as a heating medium for the liquid contents of a still. Another object is to maintain the apparatus in continuous operation for a considerable period of time, without removing the coke-forming matter.

In the preferred form of the invention a body of hydrocarbon oil is maintained in a large cylindrical cracking still, and the hot fluid discharged from a cracking coil is utilized to heat said body of oil. The contents of the cracking coil are preferably subjected to a very high degree of heat and forced into the body of oil in the cylindrical still, the vapor passing from said coil being permitted to bubble through said body of oil. The liquid contents of the cylindrical still are thus commingled with and heated by the hot fluid discharged from the coil. The temperature of this fluid is so high that the desired cracking takes place in the still without transmitting the usual high degree of heat through the metal of the still. As a result, the transmission of heat to the body of oil is not greatly affected by the presence of coke on the still bottom, and the danger usually due to overheating a cylindrical still is almost entirely eliminated. Furthermore, the losses due to the transmission of heat through a body of coke are minimized for the coke on the still bottom does not in any way interfere with the transmission of heat from the preheated fluid to the body of oil. This hot fluid also increases the efficiency of the apparatus by circulating the liquid in the still. By eliminating the danger of overheating the cylindrical still, and at the same time subjecting the oil to the necessary high temperature, the apparatus can be operated continuously for a considerable period of time.

To fully appreciate a most important feature of this invention, it will be necessary to understand that some oils can be cracked more readily than others. High boiling point oils can be easily cracked to produce gasolene, but the same is not true of lighter oils, such as distillates of the illuminating oil series. For example, high boiling point oils, such as gas oil and fuel oil, can be very successfully cracked in a large cylindrical cracking still at a temperature of about 750° F. and a pressure of about 85 pounds per square inch, whereas lighter oils, such as distillates of the illuminating oil series, must be subjected to higher pressures and higher temperatures. In actual practice, I have found that it is economical and otherwise desirable to crack the high boiling point oils in a large fire heated cylindrical cracking still, and that lower boiling point oils of the illuminating oil series can be very successfully cracked in a cracking coil maintained at a relatively high pressure and at a correspondingly high temperature. According to the present invention, high boiling point oils and low boiling point oils are cracked simultaneously, and each body of oil is subjected to the conditions most favorable for the conversion of its constituents into cracked gasolene. The high boiling point oil, preferably gas oil or fuel oil, is cracked under pressure in an ordinary cylindrical still. The low boiling point oil, preferably a distillate of the illuminating oil series, is subjected to a higher pressure and to a higher temperature, and then discharged into the cylindrical cracking still. The different oils are thus subjected to most desirable conditions, and the fluid discharged from the hottest still is forced into the oil undergoing distillation at a lower temperature in the cylindrical still.

The drawing is a diagrammatical view of a cracking apparatus adapted for use in carrying out the new method.

To illustrate the invention I have shown a

cracking apparatus comprising a large horizontal cylindrical cracking still 1 arranged above a heating chamber 2, a vapor pipe 3 leading from said still to an air cooled reflux condenser 4, a second reflux condenser 4' arranged to receive the vapor flowing from the condenser 4, and a vapor pipe 5 connecting said reflux condenser 4' to a water cooled condenser 6 from which the product is recovered. A pressure regulating valve 7, preferably located in the vapor pipe 5, may be regulated to maintain a predetermined pressure in the reflux condensers and still 1. In the reflux condensers, the fractions having relatively high boiling points are condensed and separated from the lighter fractions which pass to the main condenser 6. The high boiling point condensate formed in the reflux condensers, flows into a pipe 8 whereby it is conducted back to the still 1.

A perforated discharge pipe 9, submerged in the lower portion of the still 1, is connected by means of a pipe 10 to the discharge end of a fire heated cracking coil 11, the latter consisting of a coil of pipe arranged within a furnace or heating chamber 12.

The apparatus herein shown is particularly adapted for use in cracking distillates or residues resulting from the distillation of petroleum. A body of hydrocarbon oil is maintained in the large cylindrical still 1, and this oil is maintained at a cracking temperature, partly by the heat transmitted from the fire in the heating chamber 2, and partly by streams of hot fluid discharged from the perforated pipe 9. A fresh charge of oil is conducted through a pipe 13 to a pump 14, which forces the oil through a pipe 15 and into the cracking coil 11. Steam passing from a pipe 16 is discharged into the pipe 15 where it commingles with the oil flowing into the coil. The mixture of steam and hydrocarbons is forced through the coil at a high velocity and discharged into the pipe 10 leading to the perforated pipe 9 at the bottom of the cylindrical still.

It will be observed that the structure herein shown comprises a primary cracking apparatus including the cracking coil 11, a secondary cracking apparatus including a large still 1, and a condenser 6 common to the primary and secondary cracking apparatus.

The oil introduced into the cracking coil may be a distillate of the illuminating oil series having a boiling point of about 500° F., and a gravity of about 42° Bé., and the body of oil introduced into the large cylindrical still 1 may be a fuel oil, or a gas oil having a gravity of about 32° Bé. and a boiling point of about 600° F. In other words, I preferably introduce a "low" boiling point distillate into the cranking coil and a "high" boiling point distillate into the cylindrical still 1. A fresh charge of the high boiling point oil may be forced from a supply pipe 18 through a pump 19 and thence through a pipe 20 to the pipe 10 leading into the still 1. To successfully crack the "low" boiling point oil, it is necessary, or desirable, to use extremely high pressures and temperatures, and it would be dangerous and uneconomical to operate the large cylindrical still 1 under such pressures and temperatures. However, the small tubes forming the cracking coil 11 can withstand a much higher pressure and a much higher temperature than the large cylindrical still. It is, therefore, an advantage to maintain the contents of the cracking coil under a higher pressure and at a higher temperature than the cylindrical still. The difference in pressure can be obtained by adjusting a valve 21 in the pipe 10 leading from the cracking coil to the cylindrical still.

The content of the cracking coil may, for example, be subjected to the pressure of about 150 pounds per square inch, and a temperature of about 900° F., while the contents of the cylindrical still 1 are maintained at a pressure of about 85 pounds per square inch and a temperature of about 750° F. It will, of course, be understood that the invention is not in any way limited to the use of any specific pressure, nor to any particular temperature, but it is important to observe that the "low" boiling point oil in the cracking coil is subjected to a higher pressure and to a higher temperature than the pressure and temperature of the "high" boiling point oil in the large cylindrical still. The reasons for these differences in pressure and temperature have already been pointed out.

The vapor discharged from the cracking coil at a very high temperature bubbles through the body of oil in the cylindrical still, and serves as a very effective heating medium for the oil. By transmitting heat to the interior of the cylindrical still in this manner, a lower fire can be used under the cylindrical still, thus economizing in the use of fuel and avoiding the danger of overheating the bottom of the cylindrical still.

I claim:—

1. In the art of cracking high boiling point and low boiling point hydrocarbon oils, the method which comprises maintaining a body of the high boiling point oil in a cracking still, forcing the low boiling point oil into a cracking coil, discharging the contents of the cracking coil into said high boiling point oil in the still, maintaining the low boiling point oil under a relatively high pressure and at a relatively high temperature, and maintaining the high boiling point oil under a lower pressure and at a lower temperature.

2. In the art of cracking high boiling

point and low boiling point hydrocarbon oils, the method which comprises maintaining a body of the high boiling point oil in a large cylindrical cracking still, forcing the low boiling point oil into a cracking coil, subjecting the high boiling point oil in the cylindrical still to a cracking temperature and a cracking pressure, subjecting the low boiling point oil in the cracking coil to a pressure and temperature higher than that of the cylindrical still, and at the same time discharging the cracked product from the cracking coil and into the oil in said cylindrical still.

3. In the art of cracking high boiling point and low boiling point hydrocarbon oils, the method which comprises maintaining a body of gas oil in a cracking still, forcing a distillate of the illuminating oil series into a cracking coil, discharging the contents of the cracking coil into the oil in said still, maintaining the distillate of the illuminating oil series under a relatively high pressure and at a relatively high temperature, and maintaining the gas oil under a lower pressure and at a lower temperature.

4. In the art of cracking high boiling point and low boiling point hydrocarbon oils, the method which comprises maintaining a body of the high boiling point oil in a large cylindrical cracking still, forcing a low boiling point oil of the illuminating series into a cracking coil, subjecting the high boiling point oil in the cylindrical still to a cracking temperature and a cracking pressure greater than 50 pounds per square inch, subjecting the low boiling point oil of the illuminating series in the cracking coil to a pressure and temperature higher than that of the oil in the cylindrical still, and at the same time discharging the cracked product from the cracking coil and into the oil in said cylindrical still.

5. In the art of cracking high boiling point and low boiling point hydrocarbon oils, the method which comprises maintaining a body of the high boiling point oil in a cracking still, forcing the low boiling point oil into a cracking coil, commingling steam with the low boiling point oil in the cracking coil, discharging the contents of the cracking coil into the oil in said still, maintaining the steam and low boiling point oil under a relatively high pressure and at a relatively high temperature, and maintaining the high boiling point oil under a lower pressure and at a lower temperature sufficient for cracking.

In testimony that I claim the foregoing I hereunto affix my signature.

JOHN W. COAST, Jr.

3352

C. ELLIS.

MAKING GASOLENE SUBSTITUTE.

APPLICATION FILED OCT. 4, 1913.

1,396,999.

Patented Nov. 15, 1921.

3 SHEETS—SHEET 1.

Fig. 1.

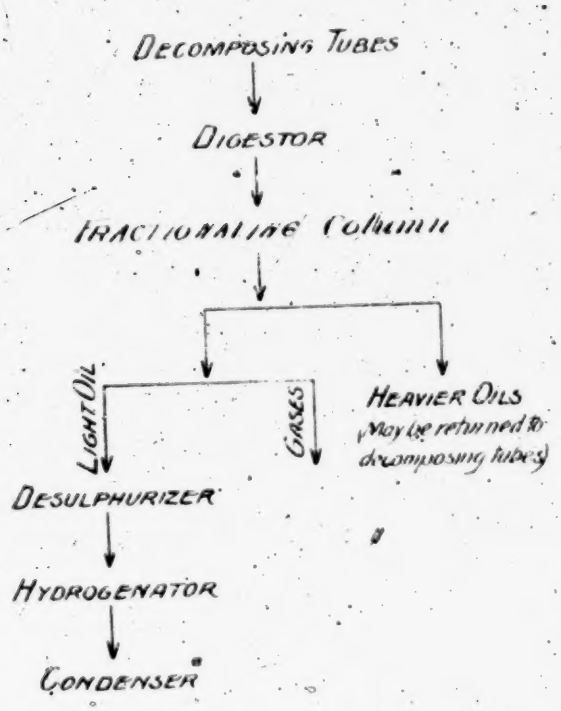
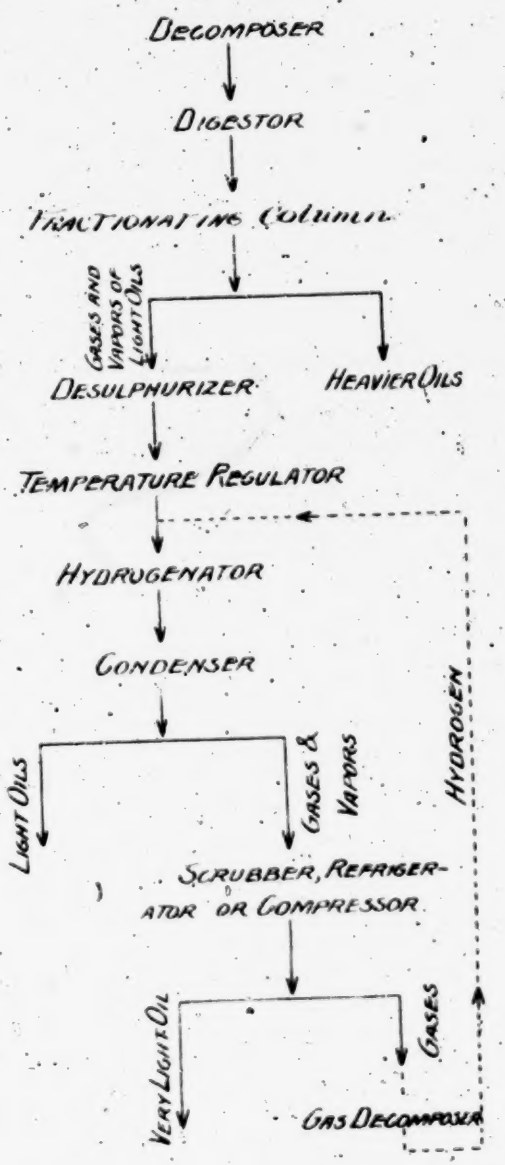


Fig. 2.



Witnesses:

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3354

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APPLICATION FILED OCT. 4, 1913.

1,396,999. Patented Nov. 15, 1921.

3 SHEETS—SHEET 2.

Fig. 3.

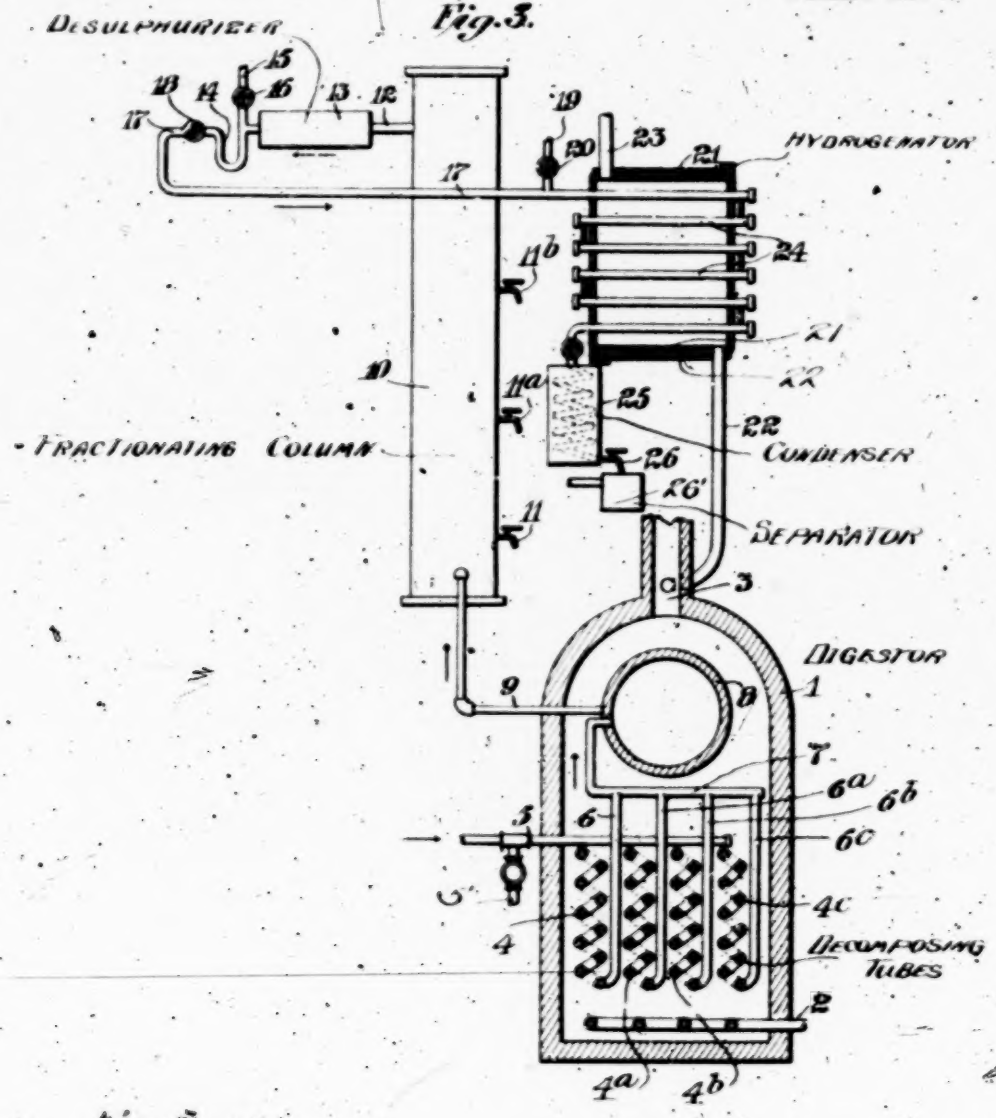

Fig. 3.

Witnesses:

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3356

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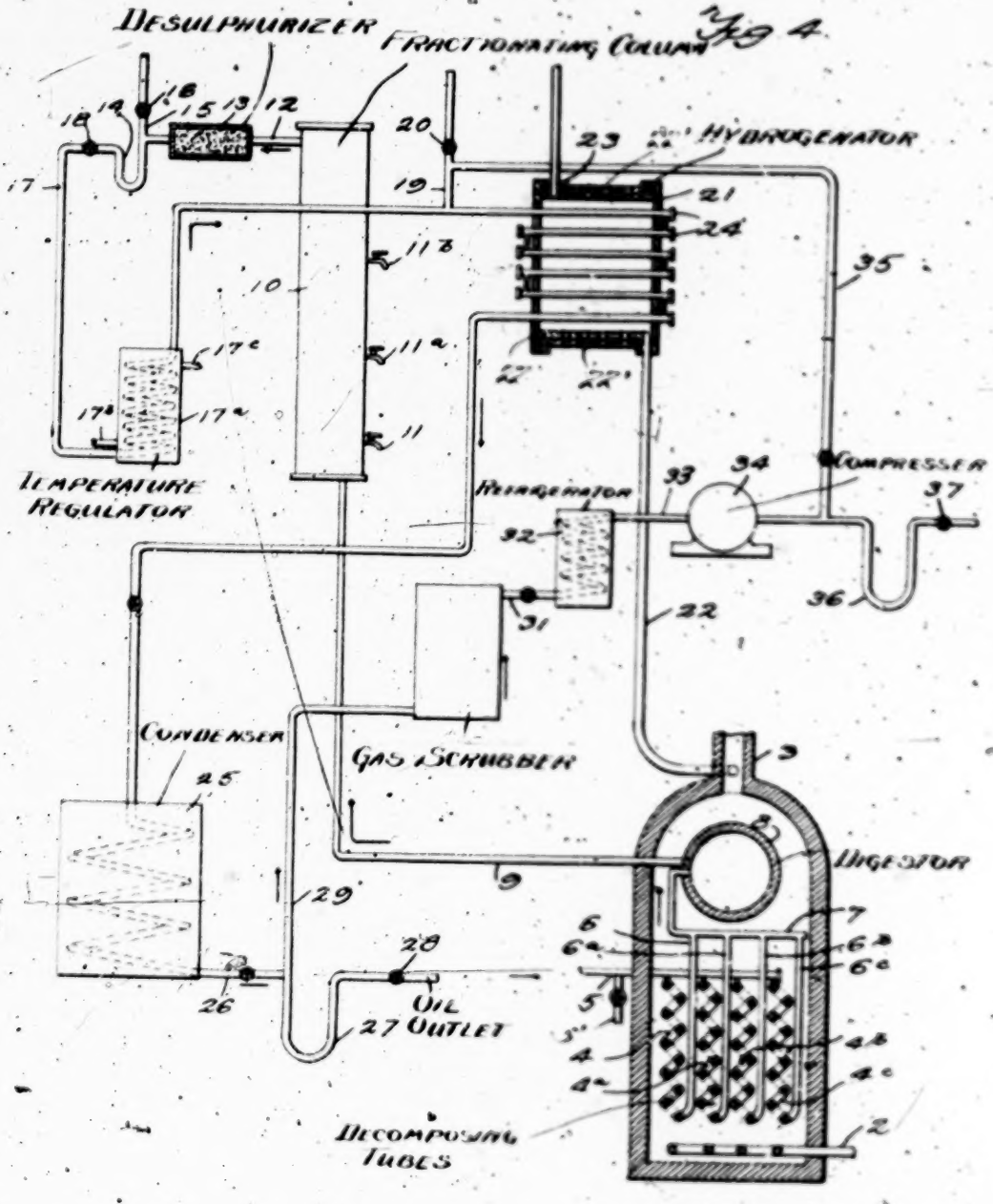
1,396,999.

Patented Nov. 15, 1921.

3 SHEETS—SHEET 3.

Fig 4.



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UNITED STATES PATENT OFFICE.

CARLETON ELLIS, OF MONTCLAIR, NEW JERSEY.

MAKING GASOLENE SUBSTITUTE.

1,396,999. Specification of Letters Patent. Patented Nov. 15, 1921.

Application filed October 4, 1913. Serial No. 793,377.

To all whom it may concern:

Be it known that I, CARLETON ELLIS, a citizen of the United States, and a resident of Montclair, in the county of Essex and State of New Jersey, have invented certain new and useful Improvements in Making Gasolene Substitutes, of which the following is a specification.

This invention relates to a process of making gasolene from heavier oils such as kerosene and the like and is related in particular to a system or organization of correlated elements: the whole forming an integral process or organization whereby from heavier oils there may be obtained lighter fractions akin to or suitable for use in place of ordinary gasolene.

In order to render the nature of the organization clear, I have appended two plans showing the path of material undergoing treatment, this being indicated by Figures 1 and 2; while Fig. 3 shows a structure suitable for carrying out the procedure indicated by Fig. 1 and Fig. 4 apparatus for carrying out the procedure indicated by Fig. 2. Fig. 3 is shown mainly in sectional elevation, and, in a diagrammatic manner, shows the heating and condensing system and stabilizing means adapted for carrying out the present system. Fig. 4 shows in a diagrammatic manner a modified form of the apparatus illustrated in Fig. 3 including also additional apparatus hereinafter referred to in the description of the process indicated by Fig. 2. Fig. 5 is a detail sectional view of one of the decomposing tubes showing the manner in which the catalytic material is placed therein.

By referring to Fig. 1 it will be noted that the first member is a decomposer or decomposing tubes. This element may consist of a series of tubes placed in a furnace and adapted to be heated to a temperature of 400–600° C. or so, while the heavier oil passes through in the form of a vapor and is subjected to thermal decomposition during such travel. Of course, the tubes may be long or short according to the velocity of travel of the oil vapors with respect to the temperature of the surrounding gases applied for heating such tubes. Into the decomposer may be admitted along with the oil or oil vapors a quantity of steam so as to provide 20–50% of water more or less, based on the nature of the oil employed. In place of a tubular structure a retort or still may be employed. In the decomposing tubes I preferably place catalytic material, preferably metal bodies of a shape adapted to form baffling surfaces while permitting a ready flow of the vapor.

Metal which is a good conductor of heat preferably is employed in order by rapid conduction to prevent a cold core of gases along the middle of the tube rendering that part of the tube without effective action. During the first part of the travel of the oil vapors for effective action I preferably bring them into contact with surfaces of copper and in the latter part of the travel with surfaces of nickel. This may be accomplished by plating "jackstones" and the like with copper or respectively with nickel and packing the tubes with the jack stones which pack in such a way that the greatest baffling effect is secured at the center and most rapid travel at the circumference of the tube which, of course, is hottest and therefore an automatic equalization of temperature is secured.

A single passage of the heavy oil through the apparatus should yield an amount of light products adapted for use as a gasolene substitute equivalent to from 20 to 40 per cent. of the original oil treated. After the oil vapors have been decomposed to the required degree, they are passed preferably to a digester which may be and preferably is a vessel well insulated to prevent loss of heat in which container the heated vapors undergo digestion or reaction among themselves and more or less stabilization with establishment of certain conditions of equilibrium which could not be secured satisfactorily in the decomposing tubes where strong heat is being applied externally.

The decomposition products contain unstable constituents which, in the digester, react with the gases present and particularly hydrogen, or with each other or by polymerization, to produce more stable compounds in substantial molecular equilibrium. From the digester the vapors may go to a dephlegmator or fractioning column which preferably is of a type used in the rectification of alcohol and the like in place

of the ordinary coarse dephlegmator used in the present day rectification of oil. In the dephlegmator, or fractioning column the heavy oil is condensed and if desired a dephlegmator may be arranged to yield as fractions a gas oil and unconverted kerosene especially if the latter is employed as the raw material. Preferably, however, the kerosene is separated from the heavier oils and the former returned to the decomposing tubes while the latter which is preferably separated as a fraction similar to gas oil, is collected and suitable disposition made thereof.

The lighter oils or volatile spirits are not condensed in the dephlegmator and preferably passed into a desulfurator which may be a tube containing copper filings or copper oxid or other metallic or non-metallic desulfuring agent maintained at a temperature suitable for satisfactory desulfurization. Preferably, however, a desulfuring agent similar to that employed in the subsequent process of hydrogenation is made use of.

Oils which have been purified for the market such as, for example, ordinary lamp oil or kerosene contain very little sulfur as a rule, but enough is usually present to affect the catalyzer employed in the hydrogenation step which is subsequently to be described, and in that case the sulfur has to be removed in order to secure a catalyzer of sufficient endurance. When using a catalyzer such as nickel or cobalt, traces of sulfur or chlorin act in a poisonous manner rendering the catalyzer in a short time wholly inert. Oils which have been sufficiently desulfurized for commercial purposes often have enough sulfur or other toxic agents to decrease the catalytic activity, because of the great sensitiveness of these catalytic bodies to catalyzer poisons. Hence if nickel is employed as a catalyzer, preferably the spent nickel catalyzer, that is to say the catalyzer which has lost its catalytic activity, may be employed for removing those traces of divers bodies which act poisonously. While copper oxid and the like will remove sulfur in a commercially satisfactory way, it is better, as stated, when removing sulfur to fit an oil for catalytic hydrogenation to use as a desulfurizing agent the catalyzer itself or spent masses of the same, as thereby the specific selective action of the metal and removal of the particular traces of sulfur or other toxic agents acting on the catalyzer is satisfactorily effected, which oftentimes may not be the case when using metals or compounds of dissimilar affinities for the sulfur and other toxic agents.

The product having been suitably prepared in this or other manner for hydrogenation, it is now preferably passed through a hydrogenating apparatus in which it contacts with nickel or other catalyzer in the presence of hydrogen. The nickel is preferably carried on a support of the nature of crushed glass or other dense impermeable material. The glass is preferably fairly uniformly plated with a very thin layer of nickel material. A temperature between 200–300° C. preferably is maintained in the hydrogenator during the operation. The product then passes to a condenser where it may be obtained in a suitable form for the market or, if desired, may be re-distilled or treated with sulfuric acid and alkali or subjected to any other method of treatment, although in general it is sufficient to simply pass the product through the hydrogenator in order to add hydrogen and thereby satisfy the unstable bodies present, as this usually affords a product of good color, odor and stability.

In Fig. 2 the light fraction passes from the dephlegmator uncondensed, the lighter oils and gases being mingled; while according to the plan of Fig. 1, the gas may be removed from the condensed light oils at the dephlegmator. The uncondensed vapors may then pass to a desulfurator and through a temperature regulator where the temperature of the vapors may be adjusted to about 240° C. whereupon they may be introduced into the hydrogenator wherein the free hydrogen contained in the gases of decomposition from the decomposing tubes may be caused to unite with the oil vapors. Hydrogen, of course, may be supplied from an external source in the amount required. The product passes into a condenser and the light oils are thus obtained in a liquid form, while any excess of hydrogen and the other gases which are present containing entrained vapors may be passed to a compressor or scrubber or washer or refrigerator where any useful light oils may be recovered.

A similar operation may be employed in the case of the gas derived acording to the system indicated in Fig. 1. These gases may then be passed through a gas decomposer where they are subjected to a very high temperature in order to break down the hydrocarbons into the carbon and hydrogen and after suitable washing or other purification the hydrogen may be returned to the hydrogenator, as described in connection with Fig. 2.

In Fig. 3, 1 is a furnace structure containing a battery of heating tubes as shown at 4, 4^a, 4^b, and 4^c. These consist of pipes set horizontally or practically so, connected end to end in such a manner as to form a continuous passage from the upper horizontal tubes to the lower ones. They are heated by fuel gas supplied through the pipes 2. 3 is a chimney for the spent gases

or products of combustion. The tubes 4, 4^a, 4^b, 4^c, may be filled with catalytic and heat-conducting material as shown at 3' (Fig. 5), the uppermost pipes preferably containing copper fragments and the lowermost preferably carrying nickel bodies. A feed-pipe 5 serves for the introduction of oil, oil vapor, oil and water, steam and oil, or the vapors of steam and oil. As shown, a branch pipe 5' may be provided for the introduction of steam or water, the pipe being provided with a suitable valve to permit regulation of the proportions of oil or oil vapor and water or steam. These pass downwardly through the several series of heating pipes and then by risers 6, 6^a, 6^b, and 6^c, are taken to the manifold 7 which communicates with the digester drum 8. This drum is preferably of considerable length in reference to the diameter and has an inlet for the oil vapors at one end, while the outlet represented in the drawing by 9 preferably is at the other end. The products of combustion from the heaters below the decomposing tubes pass up and around the drum and in some cases may add heat to it and in other cases may serve more as an insulating blanket of heated air to prevent any substantial drop of temperature in the digester 8.

The slow travel of the vapors through the drum enables molecular equilibrium to be established to a considerable degree. The pipe 9 leads to a dephlegmator 10 which may be a column apparatus of a type adapted to make fairly sharp separation of close boiling fractions. These may be withdrawn at 11, 11^a and 11^b. A pipe 12 carries the light distillate to a desulfurizer 13 which preferably is filled with spent nickel catalyzer. Gases are withdrawn by the pipe 15 which carries the valve 16. 14 is a trap which enables the gases to be collected at that point. 17 is a pipe leading to the hydrogenator 21. The pipe 17 carries the valve 18. 19 is a pipe serving to introduce hydrogen or other suitable reducing gas, the flow of which therethrough being regulated by the valve 20. A flue 22 conducts gases from the stack 3 to the hydrogenator 21 in order to furnish heat for the latter, air being admitted to the hydrogenator by openings, whereby suitable control of temperature is secured which preferably should be between 240-250° C. The hydrogenator as shown consists of a series of tubes 24 connected to form a continuous passage, in the tubes being placed nickel or other catalyzer, but preferably nickel plated or coated on dense impermeable fragments or granules of such a character as to prevent the vapors from permeating the support. The temperature of the hydrogenator may be regulated by admitting any desired quantity of air in addition to the products of combustion from the pipe 22. As shown, the casing 21 is provided with openings 21' and shutters or valves 22' are arranged over these openings to permit regulation of the air feed. Thus recovery of the catalyzer when as such it can no longer be used, is made possible, which is difficult when the metal is lodged inside a porous carrier as would be the case with a porous support, causing trouble in regeneration. From the tubes 24, the light oil products are conveyed to a condenser 25 where any remaining condensable fractions are liquefied. The finished product is removed from the condenser by outlet 26, and may be delivered to a separator 26' for the purpose of removing any excess water. The material obtained from the outlet 26 or the separator 26' is composed of low boiling saturated hydrocarbons of the nature of gasolene. From the tubes 24 of the hydrogenator 21 the product passes through the condenser 25 provided with the valved outlet 26.

Porous bodies sometimes show a tendency to selectively absorb some portion of the oil, thus tending to clog the catalyzer. Also in the preparation of the catalyzer with a porous support, it is difficult owing to an occlusive force to free such catalyzer from objectionable impurities by washing. Again there is the difficulty of securing a satisfactory coating of materials; so for these and for other reasons a carrier of the nature of glass or metal preferably is employed as a support. Thus iron, copper and aluminum and the like may be employed.

In the somewhat modified form of apparatus shown in Fig. 4, employed in carrying out the procedure indicated by Fig. 2, a temperature regulator 17^a having an inlet 17^b and an outlet 17^c for a suitable temperature regulating fluid is preferably connected in pipe 17 between the desulfurizer 13 and the hydrogenator 21. The temperature of the vapors is preferably adjusted in the temperature regulator 17^a to about 240° C. In this form of apparatus the valved outlet 26 from the condenser 25 is connected with a trap 27 where the light oils may be obtained in liquid form and drawn off through the valved outlet 28. The uncondensed gases may advantageously pass through pipe 29 to a scrubber or washer 30 then through the valved connecting pipe 31 to a refrigerator 32 then through pipe 33 to a compressor 34 from which the uncondensed portion of the product is returned through valve pipes 35 and 19 to the hydrogenator 21 as hereinabove described in connection with Fig. 2, the condensed portion of the product passing from the compressor 34 may be caught in the trap 36 and drawn off through the valve controlled outlet 37.

The desulfurizer may be placed in any

one of several locations and may be omitted when the oil is sufficiently free from toxic bodies to have no substantial or objectionable effect on the catalyzer. When water is used in the decomposing tube and an excess is employed this will appear later, on condensation and suitable means should be provided for its removal. The apparatus is preferably run at a slight pressure although a considerable pressure, as several atmospheres may be employed if desired.

The foregoing description of the present system of treatment is not to be construed as a limitation by virtue of any detail herein specified as various deviations therefrom will now be evident to those skilled in this art. For example, various elements may be eliminated under due circumstances, such as the desulfurizer when the oil is at the start sufficiently free from sulfur poisons. Or various elements may be added to the present system, or hydrogenation of the unsaturated components may take place in the liquid state, instead of in the vapor state as specified; the oil then for example being contacted under pressure with finely-divided catalyzer as hydrogen is caused to pass through or contact with the oil while the catalyzer is maintained well intermingled with the oil by any suitable means.

What I claim is:

1. The system of making a gasolene substitute which comprises passing a kerosene or heavier oil through a heated zone wherein decomposition of the oil takes place, in passing the products of decomposition into a digestion chamber and exposing said vapors to digesting conditions, fractionating to remove the heavy fractions, desulfuring the light fractions and hydrogenating same.

2. The system of making gasolene substitute which comprises passing kerosene material through a heated zone in the presence of heat-conducting and catalytic material, in allowing the decomposed material to inter-react to establish equilibrium by digestion, in fractionating same, in collecting the light oil, removing any toxic traces of sulfur present and in hydrogenating the product.

3. The system of making a gasolene substitute which comprises passing kerosene vapors and the like admixed with the vapors of steam through a long passage way heated to a temperature between 400–600° C. and containing first a quantity of metal material comprising copper and second in series a quantity of metal material comprising nickel, in withdrawing the products of decomposition, passing same into and through a digester of great length in order to establish equilibrium in part, in fractionating in collecting the heavy oil as gas oil and kerosene on the one hand and light volatile oil on the other hand, in removing any toxic traces of sulfur from the light volatile oil, and in combining hydrogen with said light volatile oil.

4. The system of making a gasolene substitute which comprises passing kerosene vapors and the like admixed with the vapors of steam through a long passage way heated to a temperature between 400–600° C. and containing first a quantity of metal material comprising copper and second a quantity of metal material comprising nickel, in withdrawing the products of decomposition and passing these through a digestion conduit of great length, in fractionating, in collecting the heavy oil as gas oil and kerosene on the one hand and light volatile oil on the other hand, in removing any toxic traces of sulfur from the light volatile oil, and in combining hydrogen with said light volatile oil.

5. The system of making a gasolene substitute which comprises passing oils heavier than gasolene through a heat decomposing zone, in digesting the products of decomposition for a protracted period whereby stable saturated bodies are formed, in fractionating to remove the heavier oils, in collecting the uncondensed vapors of light oils and accompanying gases, in passing same through a desulfurizer to remove traces of toxic bodies, in adjusting the temperature to approximately 240–250° C., in passing the vapors and gases through a mass of nickel material in the presence of hydrogen, in condensing the light volatile oil stabilized by hydrogenation, in collecting the gases and removing therefrom the entrained vapors, in combining the very light oils thus secured or any suitable portion thereof with the aforesaid light oils coming from the condensing apparatus, in submitting some portion at least of said gases to a high temperature, whereby decomposition of hydrocarbons takes place, in freeing the hydrogen thereby secured from objectionable impurities and returning same to the zone of hydrogenation.

6. The system of making a gasolene substitute which comprises passing oils heavier than gasolene through a heat decomposing zone, in stabilizing by digesting the products of de omposition, in fractionating to remove the heavier oils, in collecting the uncondensed vapors of light oils and accompanying gases, in passing same through a desulfurizer to remove traces of toxic bodies, in adjusting the temperature to approximately 240–250° C., in passing the vapors and gases through a mass of nickel material in the presence of hydrogen, in condensing the light volatile oil stabilized by hydrogenation, in collecting the gases and removing therefrom the entrained vapors, in combining the very light oils thus secured or any portion thereof with the aforesaid

light oils coming from the condensing apparatus, in submitting some portion at least of said gases to a high temperature, whereby decomposition of hydrocarbons takes place, in freeing the hydrogen thereby secured from objectionable impurities and returning same to the zone of hydrogenation.

7. The system of making a gasolene substitute which comprises passing oils heavier than gasolene through a heat decomposing zone, in fractionating to remove the heavier oils, in collecting the uncondensed vapors of light oils and accompanying gases, in saturating these in part by digesting causing interaction and formation of more stable products, in passing the vapors and gases through a mass of nickel material in the presence of hydrogen, in condensing the light volatile oil stabilized by hydrogenation, in collecting the gases and removing therefrom the entrained vapors, in combining the very light oils thus secured or any suitable portion thereof with the aforesaid light oils coming from the condensing apparatus, in submitting some portion at least of said gases to a higher temperature, whereby decomposition of hydrocarbons takes place, in freeing the hydrogen thereby secured from objectionable impurities and returning same to the zone of hydrogenation.

8. The process of producing gasolene-like material from heavier oil which consists in heating it to the decomposition temperature of the principal constituents thereof, digesting the resulting decomposition products by holding such products without the substantial loss of heat so that they react upon themselves, and hydrogenating the gasolene-like material produced.

9. The process of producing gasolene-like material from heavier oil which consists in heating it to the decomposition temperature of the principal constituents thereof, digesting the resulting decomposition products by holding such products without the substantial loss of heat so that they react upon themselves, and hydrogenating the gasolene-like material produced by subjecting it to the action of hydrogen in the presence of a catalyzer carried by non-porous material, at an elevated temperature.

10. The process of producing gasolene-like material from heavier oil which consists in heating it to the decomposition temperature of the principal constituents thereof, digesting the resulting decomposition products by holding such products without the substantial loss of heat so that they react upon themselves, and hydrogenating the gasolene-like material produced by subjecting it to the action of hydrogen in the presence of nickel plated upon a vitreous support, at an elevated temperature.

11. The process of producing gasolene-like material from heavier oil which consists in heating it to the decomposition temperature of the principal constituents thereof, digesting the resulting decomposition products, by holding such products without the substantial loss of heat so that they react upon themselves, removing catalyzer poisons from the gasolene-like material produced and hydrogenating such gasolene-like material.

12. The process of producing gasolene-like material from heavier oil which consists in heating it to the decomposition temperature of the principal constitutents thereof, digesting the resulting decomposition products, removing catalyzer poisons from the gasolene-like material produced, by the action of spent catalyzer and hydrogenating the thus purified product.

13. A stabilized gasolene-like product comprising digested and hydrogenated volatile petroleum material.

14. A gasolene-like product comprising digested and hydrogenated decomposition products of petroleum oil.

Signed at Montclair in the county of Essex and State of New Jersey this 2nd day of October, A. D. 1915.

CARLETON ELLIS.

Witnesses:
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3364

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MANUFACTURE OF MOTOR FUEL.

APPLICATION FILED NOV. 30, 1917.

1,407,619.

Patented Feb. 21, 1922.

5 SHEETS—SHEET 1.

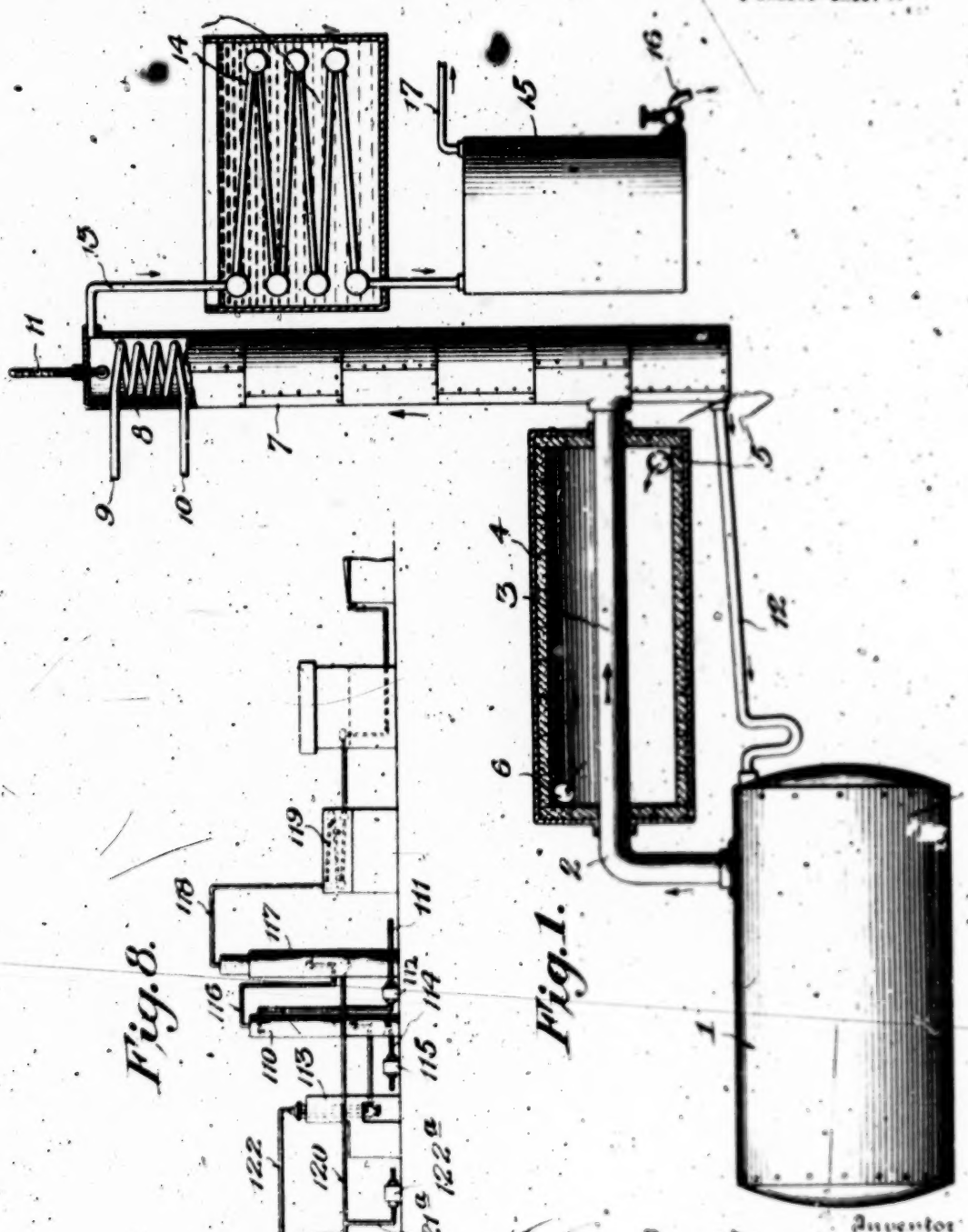

Fig. 1.

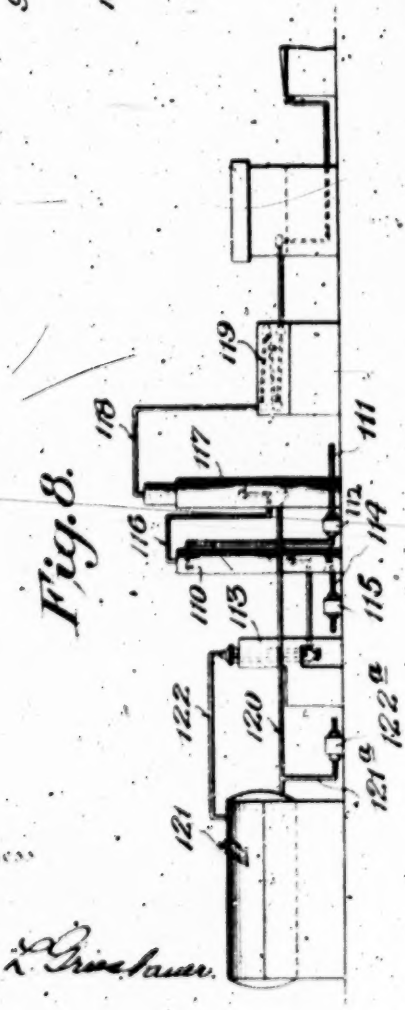

Fig. 8.

Witness

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MANUFACTURE OF MOTOR FUEL.

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5 SHEETS—SHEET 2.

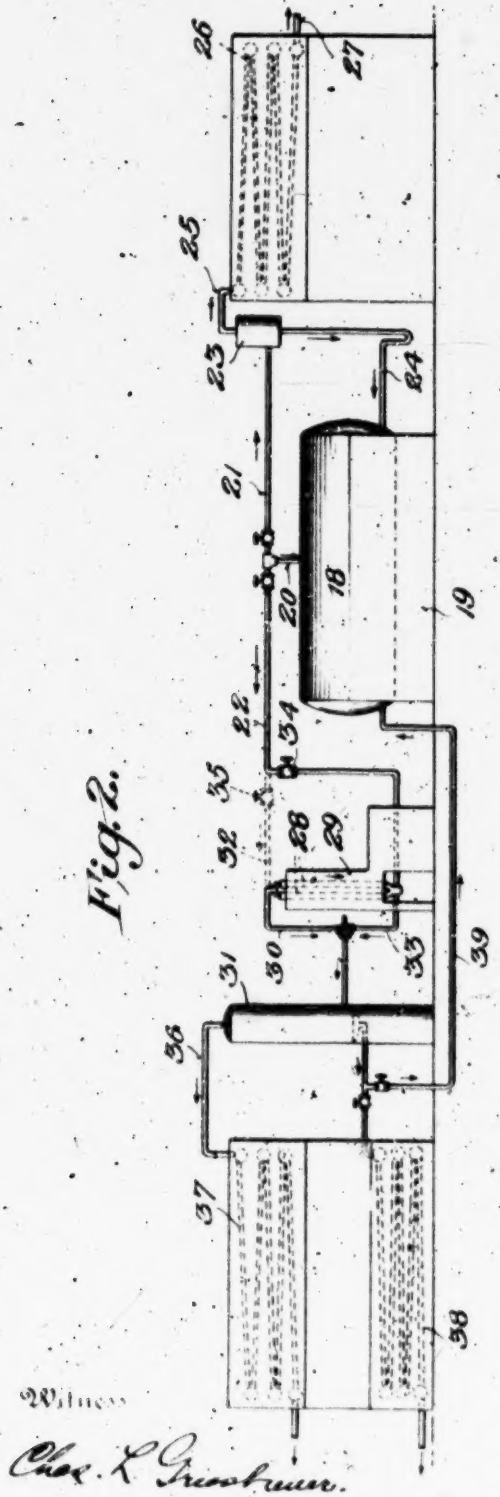

Fig. 2.

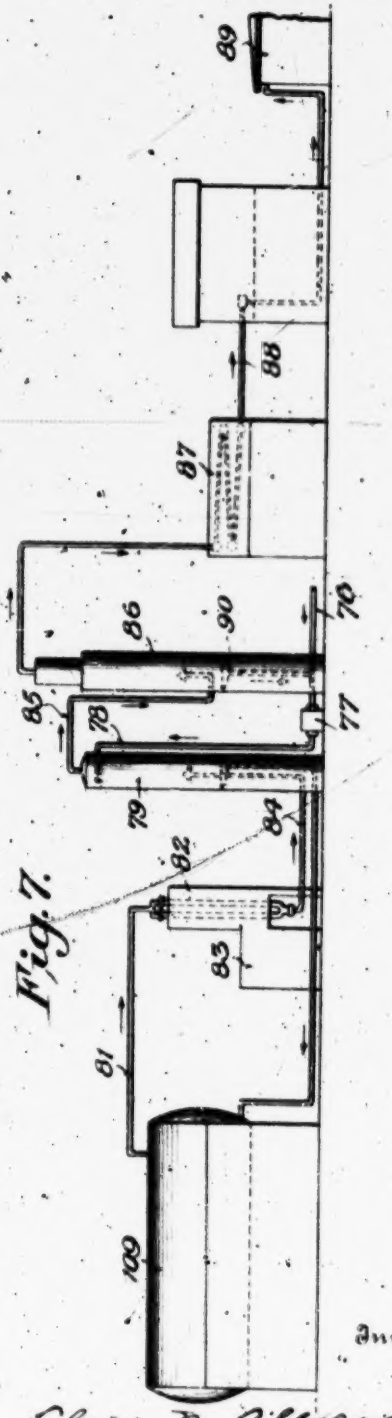

Fig. 7.

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MANUFACTURE OF MOTOR FUEL.

APPLICATION FILED NOV. 30, 1917.

1,407,619. Patented Feb. 21, 1922.

5 SHEETS—SHEET 3.

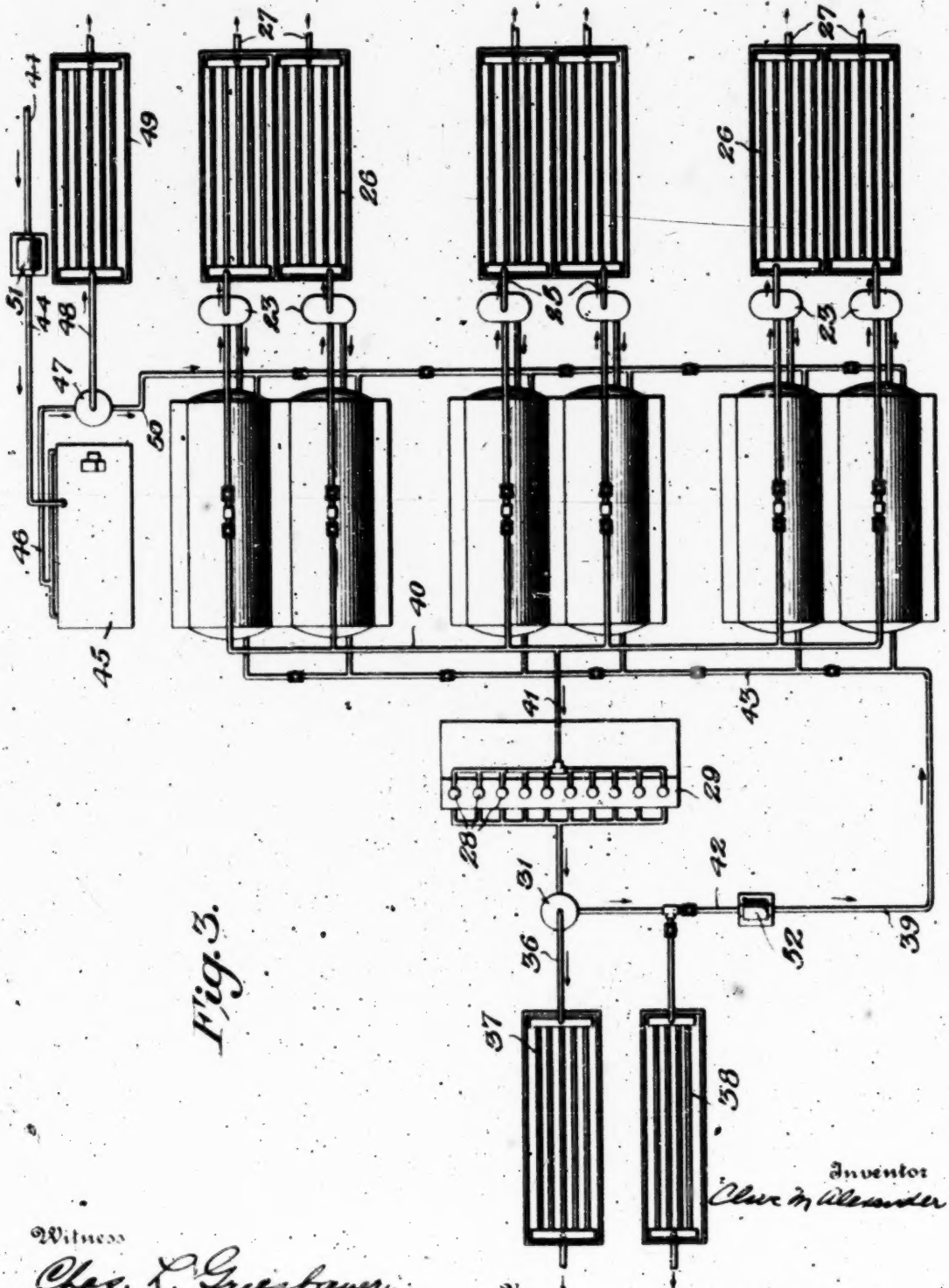

Fig. 3.

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MANUFACTURE OF MOTOR FUEL.

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5 SHEETS—SHEET 4.

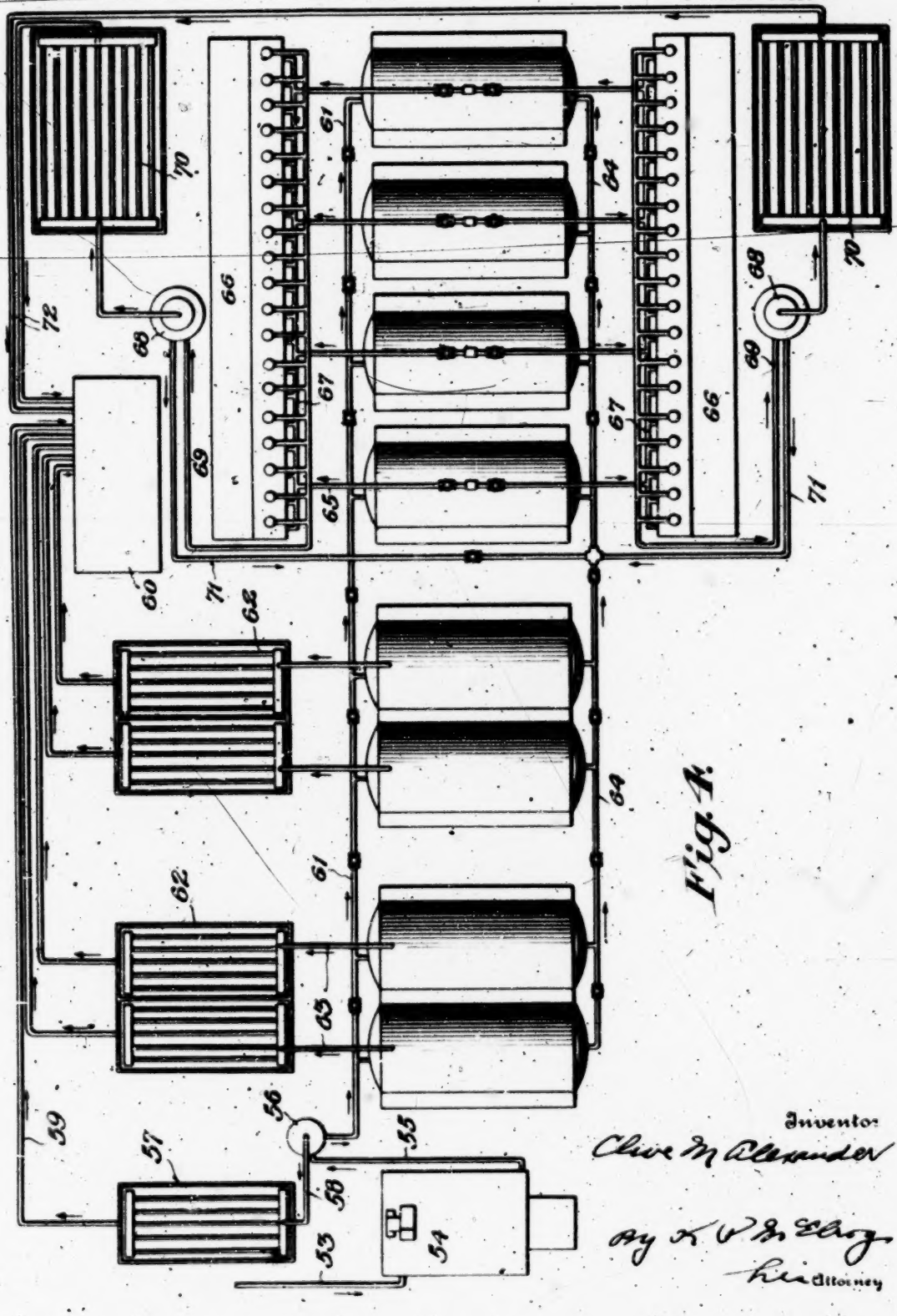

Fig. 4.

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MANUFACTURE OF MOTOR FUEL.

APPLICATION FILED NOV. 30, 1917.

1,407,619. Patented Feb. 21, 1922.

5 SHEETS—SHEET 5.

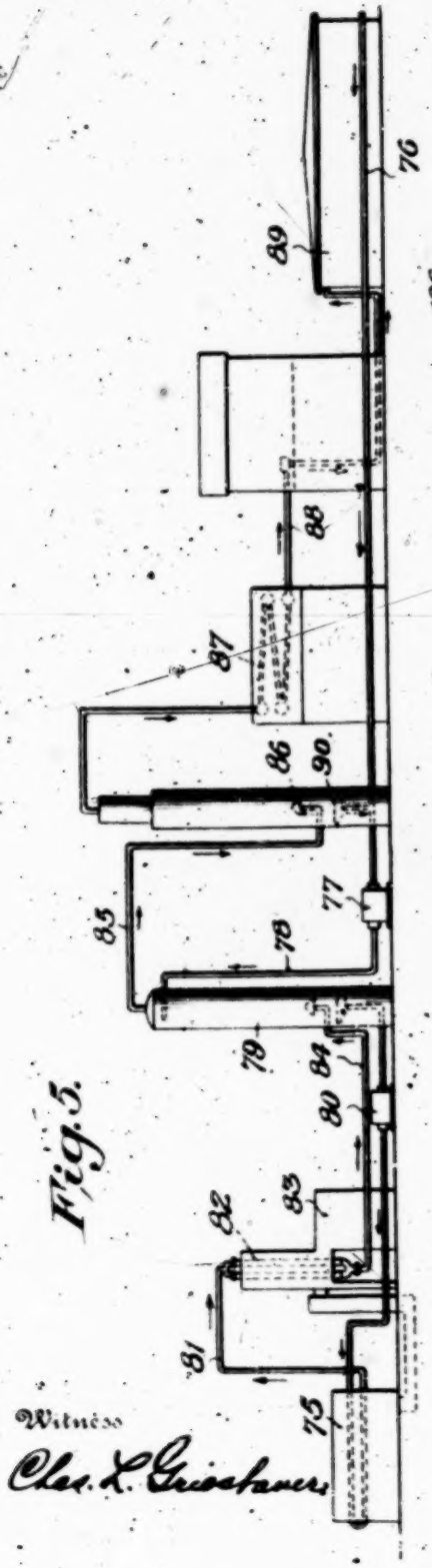

Fig. 5.

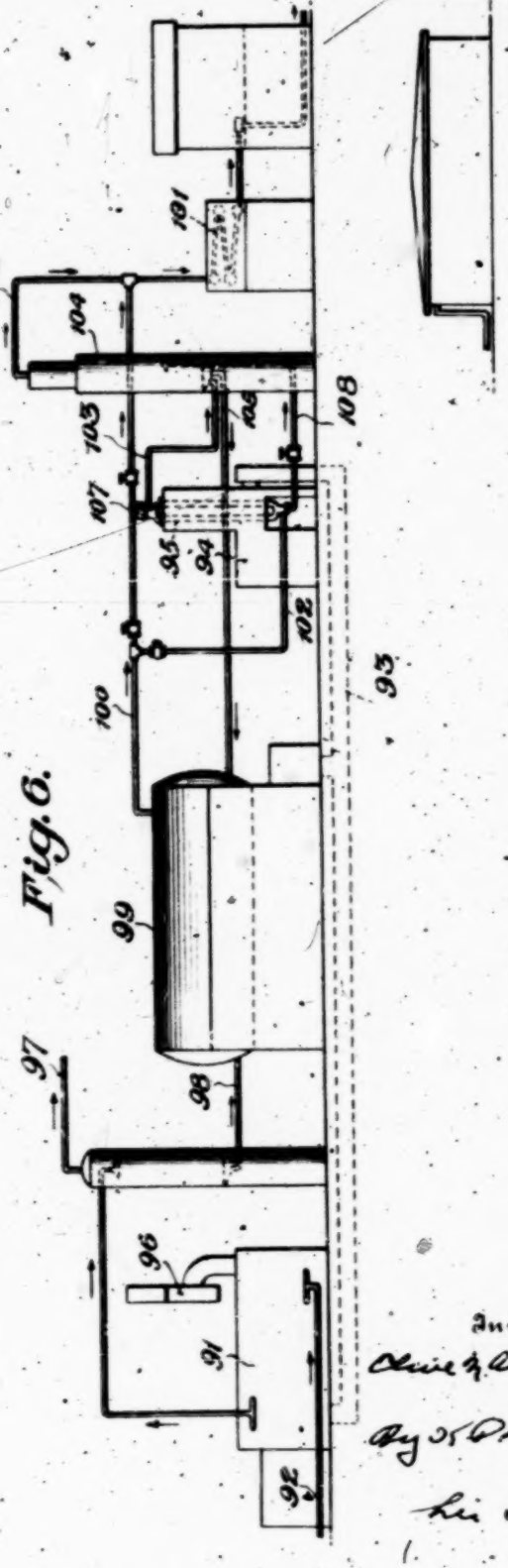

Fig. 6.

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Inventor
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By his Attorney
Lee Attorney

UNITED STATES PATENT OFFICE.

CLIVE M. ALEXANDER, OF PORT ARTHUR, TEXAS, ASSIGNOR TO GULF REFINING COMPANY, OF PITTSBURGH, PENNSYLVANIA, A CORPORATION OF TEXAS.

MANUFACTURE OF MOTOR FUEL.

1,407,619. Specification of Letters Patent. Patented Feb. 21, 1922.

Application filed November 30, 1917. Serial No. 204,635.

To all whom it may concern:

Be it known that I, CLIVE M. ALEXANDER, a citizen of the United States, residing at Port Arthur, in the county of Jefferson and State of Texas, have invented certain new and useful Improvements in Manufacture of Motor Fuels, of which the following is a specification.

This invention relates to the manufacture of motor fuels; and it comprises a method of making motor fuels of the nature of gasoline and containing large proportions of readily volatile, readily ignitable hydrocarbons from petroleum materials of higher initial boiling point, (such as crude petroleums and petroleum residue and distillates such as gas oil, solar oil, kerosene), by cracking such higher boiling oils with the aid of heat wherein the higher boiling oils are vaporized (with or without cracking according to the nature of the oil) and the vapors are passed through a tubular cracking zone, the temperature of such zone, its length and the volume of vapors passed through such zone being so correlated that only a partial cracking occurs therein and much of the vapors so passed emerges uncracked, the general rule being to carry the cracking only so far that at least 40 or 70 per cent of oil of as high boiling point as the initial oil can be, and is, recovered;—the high boiling oil so recovered being, if desired, returned to the still or other source of vapors; and it more particularly comprises a method of making motor fuels in the distillation of petroleum materials, such as crude oil, wherein such materials are distilled down in stages in a still provided with the usual air cooled tower or dephlegmator (which may be arranged to drain back to the still) and with the usual positively cooled condensers beyond, the vapors in one stage of the operation being sent directly to said plurality of condensers and at another stage being sent thither through a cracking tube or retort; all as more fully hereinafter set forth and as claimed.

In view of the extended use of gasoline engines many efforts have been made to develop new sources of motor fuel adapted for use in internal combustion engines. Many mixtures of various combustible liquids have been proposed as gasoline substitutes and many methods have been suggested, and to some extent are in use, for increasing the yield of "gasoline" from petroleum. Most of the substitutes and most of the products of these methods, are not wholly composed of easily volatile oils or substances. With the usual types of carbureters, it is only necessary that some portion of the composition be readily volatile to facilitate quick ignition. The lighter the specific gravity of a petroleum oil, the lower is its boiling point and the greater its volatility; and, vice versa, the heavier an oil, the higher is its boiling point and the less its volatility. For this reason it is customary to buy and sell gasoline on the specific gravity (Baumé degrees) since the lighter an oil is the greater is its volatility and the better it is adapted as a motor fuel. The Baumé degree alone however is not a sufficient index to the nature of an oil since obviously a mixture of rather heavy oils and rather light oils may have an average specific gravity the same as that of a distillate mainly composed of oils of medium specific gravity. For this reason, as a further characterization there is sometimes used the "end dry point"—the temperature at which the final residues of a given sample will all boil away. This indicates the character of the heavier constituents of a given gasoline or motor fuel.

All natural petroleums are mixtures of relatively heavier and relatively lighter oils; and most varieties of crude oil will give upon distillation some proportion of light oils which upon condensation can be sold as gasoline. The character of this gasoline as regards specific gravity and end dry point of course depends upon the crude oil and the circumstances of distillation; upon the amount of less volatile oils going over and collected with the more volatile oils. This natural gasoline is known as refinery gasoline.

It is a very old proposition to obtain in addition to this refinery or natural gasoline a further proportion of "cracked gasoline" produced by breaking down the heavy hydrocarbons by heat; and many ways of effecting this breaking down have been proposed. A number of these are in practical use. Any heavy oil will break down into lighter products when heated to a sufficient temperature for a sufficient time; whether the heating be of the liquid oil or of its vapors. The degree to which it breaks down depends altogether on circumstances; breaking down may go so far as to give perma-

nent gases (oil gas) as the main product or it may go only so far as to produce gasoline, or even kerosene. Most of these prior methods have failed in producing the best results, i. e., the production of a maximum amount of oils sufficiently light and volatile to be salable as gasoline. This was for the reason that the treatment was too far-going and too drastic; the effort was to produce the maximum possible amount of cracking in a given treatment. To this end, liquid oil has been superheated under pressure sufficient to keep it liquid; oil has been sprayed into very hot chambers under very high pressure; oil and oil vapors have been run over red hot catalysts; etc. These processes all produce gasoline; but they do not give high yields; there is too much decomposition of oil into gas and coke and tar.

I have found that better results can be obtained by a more moderate treatment; that it is much better not to try to do too much cracking in an operation but to leave a substantial proportion or even a major fraction of the oil unacted on. In so doing this oil acts as a shielding agent as regards the cracked products, preventing the conversion going too far. And in order that I may obtain a uniform heating and uniform action I find it is better to do the heating with the oil in a vaporized condition. The vapor I use as dry as possible, that is as free as possible of droplets or suspended portions of liquid oil. This is for the reason that the heat of vaporization of oil is quite high and in the presence of liquid oil in the cracking zone heating conditions are apt to become irregular because of the absorption of heat in vaporization; I cannot get the uniform temperature conditions throughout the mass of vapor that I strive to attain. For this reason I find it best to work with a "dry" vapor. Since as I find the matter of cracking is simply that of getting the hydrocarbon up to the right temperature and as pressure and other complications are of little or no use, I operate at about atmospheric pressure; using no more pressure in any event than is necessary to produce movement of my vapors. It is even better not to use this much pressure, or indeed to use a slight degree of vacuum since the vapors can be moved by suction as readily as by pressure and a slight degree of vacuum promotes the volatilization of any liquid oil that may be present. A little steam, up to a per cent or so, has about the same effect as the use of a slight vacuum. The use of any greater proportion of steam is not worth while and is disadvantageous because it lessens the capacity of the apparatus. It seems to have no particular influence on the cracking operation, otherwise, one way or the other. The use of catalysts is unnecessary.

By producing only a limited cracking of oil vapors at about the ordinary pressure, the operation becomes so positive that changes in conditions do not much affect the result. There is therefore no use for the complications and refinements of the prior cracking methods. As a cracking zone I ordinarily use an iron or steel tube of, say, 6 or 8 inches internal diameter which may be vertical with upward or downward flow of vapors or may be horizontal or inclined. The interior of this tube is open and unobstructed. Any ordinary heating means may be employed such as gas firing, coke firing, etc. One or more tubes may be used in a single heating chamber. No rigid control of temperature in the heating means is necessary since whatever the temperature of the iron or steel tube, as long as it is high enough, the temperature within will be governed by the amount or volume of vapors sent through. In order to produce any given average temperature of the vapors passing through the tube, the volume so transmitted may be varied. The temperature of the iron tube or the furnace chamber surrounding it may range between 450 and 700° C. (842–1292° F.) without affecting the operation. The higher the temperature the more vapor must be sent through per minute and vice versa. A temperature of 500° C. (932° F.) in the furnace chamber works well.

The conditions of operation are governed more by observation of the character of the vapors passing beyond the cracking zone than by any control of the temperature of the furnace chamber. The object is, in all cases, to effect only a partial cracking of the vapors in a single passage. Ordinarily I control conditions so that on cooling the vapors a condensate will be obtained of which at least 40 to 70 per cent (calculated on the oil used to furnish the vapors) is as high boiling as the oil used to furnish the vapors. In other words, ordinarily I only about half crack, so to speak.

The vapors supplied to the cracking zone may be those of any oil higher boiling and heavier than gasoline. Naturally, the lower boiling the oil used the easier it is to convert it into gasoline with a large yield; kerosene, for example, being easier to crack down into gasoline than is gas oil or solar oil. Kerosene can be vaporized without much cracking in the vaporization and the same is true of many gas oils and solar oils. Other oils of heavier nature generally crack down to some extent in being converted into vapors and the vapors are therefore of oils lighter than those which are distilled. Therefore in speaking of the recovery of a condensate of which 40 to 70 per cent will be as high boiling as the original oil, I wish it to be understood that I mean the 40 to 70 per cent of high boiling oil recovered will

be as high boiling as the oil that could be produced by condensing the vapors entering the cracking zone. This is for the stated reason that sometimes the oils which I use to produce the vapors crack down in the vaporization and the vapors are therefore of oils lighter than those charged to the vaporizer.

As stated, cracking always occurs when hydrocarbons are heated, heavier and higher-boiling oils being converted into lighter and lower boiling products; this change occurring whether the hydrocarbons be heated as vapors or as liquids. For practical purposes, in so far as the type of cracking here interesting is concerned, the influence of pressure is negligible and any degree of pressure greater than atmospheric is undesirable; and particularly any degree which would tend to restrain vaporization of liquid hydrocarbons. The degree of temperature attained by the hydrocarbon is a much more important factor; but in the present invention this factor is automatically controlled by the simple expedient of always keeping an excess of oil vapors in the cracking zone. Cracking probably takes place at all high temperatures to some extent; but this extent is not important with most oils, below about 600° F. and does not become energetic below, say, 700° F. At a range between 1100° and 1300° F., it is energetic and far-going, tending to resolve all oils into permanent hydrocarbon gases; while at temperatures still higher, these gases in turn break down. Between 600° and 700° F. all the petroleum oils vaporize or yield vapors (by cracking) while in this temperature range all the products here sought are vapors. In attaining temperatures over 600° F. and in cracking, heat of course must be furnished; but most of this heat is that required for vaporization (or vaporization with cracking), the amount required for the cracking of the vapors being, comparatively, little. For this reason in an embodiment of the present process wherein vapors are taken directly from a still in the course of the ordinary distillation represents an important economy of heat, it being then necessary only to furnish the slight amount of heat required for cracking. With the use of substantially dry vapors, that is vapors free from any substantial amount of liquid, it is easier to furnish a controllable degree of heat since it is not then necessary to allow additional heat for vaporization. This desirability of dry vapors in the cracking operation is one of the reasons for not using pressure, the influence of pressure being, of course, to restrain or prevent vaporization or to reliquefy vapors.

Since I am merely passing oil vapors through a hot tube and thence to a condenser without the use of complicated apparatus or processes my method lends itself readily to intercalation or interposition iln the ordinary methods of oil distillation as practiced in this country. For example, in distilling a crude oil the vapors from the still may be sent directly to the ordinary air-cooled condensing or dephlegmating tower and thence to water cooled condensers as long as the natural gasoline and burning oils are coming over and then at this time be by-passed through the cracking tube, the vapors coming from the cracking tube being then sent to the succession of condensers stated. The oil coming from the tower may be drained back directly into the still. Or the transmission of vapors directly to the tower and condenser may be interrupted at the time when the natural gasoline has come over and the following vapors of burning oil may be by-passed via the cracking tube on their way to the condensers. By provision of a cracking tube on a by-pass conduit between the still and the condensers the cracking operation may be used at any stage in the ordinary distilling processes.

I ordinarily use a succession of condensers of two different types. The first condenser, which may be air cooled or water cooled as the case may be, I maintain at a high temperature; a temperature such that high boiling oils passing through the cracking zone will be here condensed but without much condensation of gasoline. The second condenser is the ordinary water cooled type adapted to condense gasoline. The temperature at which the first condenser is to be used will of course depend upon the nature of the oil being cracked; it being maintained at a much lower temperature when kerosene is the oil undergoing the cracking than when a higher boiling oil is treated. Ordinarily, I use a common type of dephlegmator for the first condenser. In the case of high boiling oils particularly, air cooling may be sufficient; but if necessary, as is often the case in cracking kerosene, I may also water-cool. The material delivered by the second condenser is applicable for use as a motor fuel. Ordinarily its amount added to the amount of condensate in the first condenser should be at least 90 per cent of the total amount of oil vaporized; that is there should not be as much as 10 per cent disappearing as gas, tar and coke. The amount of condensate produced in the final condenser can of course be varied by control of conditions in the primary condenser. Ordinarily with 50 per cent of the oil recovered in the primary condenser the gasoline coming from the final condenser will have an end dry point under 400° F. With 40 per cent recovery in the primary condenser the end dry point of the gasoline will be 430° F., while in producing the gasoline of an end dry point of 450° F. there may be only 30

per cent recovered in the air cooled condenser.

The oil recovered in the primary condenser may be sent directly back to the still or vaporizing device and ordinarily is so sent.

A further portion of light gasoline may be obtained by scrubbing the gases passing beyond the final condenser with the aid of a little heavy oil. The gasoline is absorbed by the heavy oil and may be regained by distilling it off, the exhausted wash oil being then sent back for reuse. Or, the oil which is to be sent to the vaporizing device for furnishing vapors to pass through the cracking tube may be used in this scrubbing operation, being sent through the scrubbing device to recover gasoline vapors and being then sent directly to the still.

In producing very light, easily volatile gasolines for aeroplane engines, dry cleaning clothes, etc., it is a useful expedient to scrub in the primary condenser as well. The vapors in this condenser are hot and on contact with a little scrubbing oil they give up to it only high-boiling bodies. Where the condensate from the primary condenser is sent back to the still (as it may be), the scrubbing oil used therein may be the fresh oil to be supplied to the still.

In the accompanying illustration I have shown, more or less diagrammatically, apparatus adapted for use in the described process.

Figure 1 is an elevation partly in section of a simple type of apparatus;

Figure 2 is a similar view of an apparatus enabling utilization of the present process in distillation at any stage of such distillation;

Figure 3 is a top plan view of the apparatus similar to that shown in Figure 2 wherein a plurality of units is employed;

Figure 4 is a top plan view of another form of apparatus in which continuously operating batch stills are used with means for diverting vapors at any desired time to a cracking apparatus under the present invention;

Figure 5 is a diagrammatic elevation of an apparatus wherein oil to be vaporized is used for scrubbing in a primary condenser; and wherein two primary condensers in series are employed;

Figure 6 is a similar view illustrating means for feeding the vapors either to the top or the bottom of the cracker; and

Figure 7 is a modified type of apparatus similar to that of Figure 5.

Figure 8 is still another type of apparatus which may be employed in performing this process.

Referring to the drawings, element 1 indicates conventionally a petroleum still of any well known or suitable type, provided with vapor exit 2 in communication with the cracking tube 3 (here shown as horizontal or slightly inclined) passing through and surrounded by a suitable heating jacket 4 by the aid of which such cracking tube may be maintained at any temperature desired, such as a red heat. Any suitable firing means may be employed for this heating chamber; and there are diagrammatically shown inlet 5 for flame and flame gases and outlet 6 for products of combustion. The cracking tube 2 is in communication with a primary condenser 7 at or near the bottom. As shown, this primary condenser is of an ordinary air cooled type. In treating high boiling oils with a primary condenser of sufficient surface, additional means of cooling may not be necessary. If additional cooling is desired, it may be furnished as by the cooling coil 8 in which water is admitted at 9 and discharged at 10. As shown, temperatures at the top of the tower may be read by the aid of thermometer 11. The vapors of high boiling oils passing through the cracking zone unchanged are condensed in this column and, as shown, are returned to the still while hot by trap conduit 12 for revaporization. Uncondensed vapors leave the top of the tower through conduit 13 and go thence to a final condenser 14; here shown as of a simple water cooled type. Condensed liquids flow to receiving tank 15 whence they may be removed at outlet 16. Uncondensed gases may be led to a scrubber or point of use through 17.

In Figure 2 is shown a more complicated structure in which vapors coming from a still may be sent either to a cracking device or directly to a condenser, which in this case has the same function as the final condenser of the figure just described. The structure is useful in a method of distilling crude oil wherein first gasoline and kerosene naturally contained are directly distilled and removed and thereafter vapors are sent through a cracking tube. In this showing element 18 is a conventionally shown petroleum still having firing chamber 19. From the top of the still passes vapor conduit 20 connecting with two valved pipes, respectively, 21 and 22. Conduit 21 leads to a simple reflux condenser 23 having a trap return 24 leading back to the still. From the top of this reflux condenser uncondensed vapors pass through pipe 25 to an ordinary water cooled condensing device 26. Condensed gasoline or kerosene is removed at 27. The other vapor conduit (22) leads directly to a cracking device. As shown the vapors enter at the bottom of a heated vertical cracking tube 28 and pass upward therethrough. Surrounding the cracking conduit is a furnace chamber 29. The vapors of cracked products mixed with vapors of uncracked oil pass off at the top of the cracking tube through pipe 30 and thence to primary con-

denser 31. There are some advantages in passing the vapors upwardly through a vertical cracking tube but they may of course be passed downwardly if desired. To this end, there may be provided an alternative conduit 32 leading the vapors to the top of the cracking conduit. Cracked and uncracked vapors may then be removed from the bottom of the cracking tube through 33 and go thence to the primary condenser. Passage of vapors through these conduits may be controlled, respectively, by valves 34 and 35. From the primary condenser uncondensed vapors (gasoline or motor fuel) pass through conduit 36 to a water cooled final condenser 37 while condensed products pass from the bottom of the primary condenser through the cooling box 38. If desired, instead of sending the condensate from the primary condenser through the cooling box for such disposition as may seem proper, the hot liquor from the bottom of the primary condenser may be returned directly to the still by means of valved conduit 39.

In Figure 3 the elements similar to those of Figure 2 have the same reference numerals. This figure illustrates a plurality of stills such as that of Figure 2, all capable of supplying vapors to a common cracking device. To this end, the vapor outlet which in Figure 2 leads directly to a cracking device here communicates with a cross pipe 40 which in turn has connection through 41 with a battery of cracking tubes similar to the cracking tube of Figure 2. The battery of cracking tubes in turn communicates with primary and final condensers in the same manner as in Figure 2. The condensate from the primary condensers may be delivered through pipe 42 and cross pipe 43 to any of the stills. As in Figure 2, each of the stills is provided with a directly connected condenser (final condenser). By this arrangement, presuming the plurality of stills are operating out of phase, one or more of the stills may always be furnishing vapors for cracking to the cracking tube while other stills are performing preliminary distillation; the removel of the natural gasoline and kerosene of the crude oil. The oil may be supplied to the plurality of stills through the inlet pipe 44 leading to a preheater 45, from which any light vapors are passed through pipe 46 to a dephlegmating tower 47 and thence through pipe 48 to a condenser or cooler 49. Liquid oil leaves the base of the diphlegmating column 47 and is conducted to any one of the plurality of stills through the valved line 50. Pump 51 may be provided for delivering the oil through the preheater to the stills and pump 52 may be provided for returning to the stills hot heavy oils which are not passed to the cooling box 38.

In the apparatus of Figure 4 a description of the operation will suffice to identify the different elements. The oil enters through pipe 53 to a preheater 54 whence it is conducted by line 55 to the dephlegmator 56, the vapors therefrom being sent to a condenser 57 through pipe 58 and from such condenser as liquids through pipe 59 to the receiving means 60. The heated liquid from the dephlegmating column 56 is fed by means 61 to any one of a plurality of stills operating in parallel or in series. Ordinary distillation takes place in these stills, the kerosene, gasoline or other light vapors being conducted to condensers 62 by means of the pipes 63. After the preliminary distillation in these stills the heavy oils are conducted by pipe 64 to a plurality of cracking stills (four being shown) which may be run in series or parallel. The vapors from these stills are conducted by means of pipes 65 to crackers 66, being delivered into one of the set of cracking tubes therein by means of the mains 67. The cracked vapors pass to the preliminary condensers 68 through pipes 69 and from there to the final condensers 70. The heavy oils from the preliminary condensers 68 pass through tubes 71 back to the coking stills. The condensed final product from condensers 70 is delivered by means of pipes 72 to the receiving means 60.

In the apparatus shown in Figure 5 instead of an ordinary still there is disclosed a vaporizing device 75 to which the desired oil is fed by means of a main 76. This main leads to pump 77 which delivers the oil through pipe 78 to the top of an interchanger 79, the oil therein contacting with the vapors from the cracker as hereinafter described. After such contact the oil is forced by means of pump 80 to the vaporizer which may be heated in any known manner. From the vaporizer the vapors pass by means of pipe 81 to the top of the cracker 82 having heating chamber 83 and from the cracker the cracked products pass by means of the conduit 84 to the bottom of the heat interchanger shown where they are scrubbed by the incoming oil as just described. From the top of the heat interchanger these cracked scrubbed products may be passed by means of the line 85 to the bottom of a primary condenser 86 whence uncondensed vapors pass to the final condenser 87 and thence by means of line 88 to a storage tank 89. The condensed products in the primary condenser 86 are collected in 90 and join the crude or raw oil which is being delivered to the vaporizer 75.

In the apparatus shown in Figure 6 the crude oil is fed to a dehydrator and preheater 91 by means of the main 92. The dehydrator and preheater is furnished with hot gases from the flue 93 leading from the chamber 94 of the cracker 95 and these gases

are exhausted from the preheater by means of the fan 96. The oil is fed to the dehydrator and preheater under pump pressure and is delivered to the top of the dephlegmating column where the steam is flashed out and conducted away through pipe 97. From this tube the dehydrated oil is fed by means of pipe 98 to the still 99. The oil in this still may be given the usual preliminary treatment to produce gasoline, kerosene and other light oils if desired, in which event they are passed through pipe 100 directly to the final condenser 101. In event that it is desired to crack any one of these light oils or the vapors from the heavier oils after removal of the light oils, they may be passed to the bottom of the cracker 95 by means of the pipe 102. The cracked products may pass from the top of the cracker through pipe 103 to the bottom of the primary condenser 104, condensates therefrom being returned to the still through pipe 105. The vapors from the primary condenser may pass to the secondary condenser through the passage 106. In event it is desirable to pass the product from still 99 to the top of the cracker, this may be done through line 100 connected to the cracker at 107. In this event the vapors are delivered from the cracker through pipe 108 to the primary condenser. It is obvious that the vapors may be passed directly to the primary condenser or to the bottom or the top of the cracker by proper manipulation of the valves in the line.

Figure 7 shows an apparatus quite similar to that of Figure 5, except that a still 109 is used in the place of the vaporizer 75 shown in Figure 5. The same elements designate corresponding parts and the operation is the same.

In Figure 8 of the drawings I have shown an apparatus particularly applicable for use in the present process wherein crude oil is stripped by the aid of the cracked vapors, this oil being fed to the exchange tower 110 through pipe 111, by means of pump 112. Heat exchange and evaporation and condensation take place in the exchange tower, certain products such as gasolines, kerosenes, solar oils and gas oils being vaporized by the vapors from the cracking tube 113. The heavy fractions or residuum of the crude oil together with the heavy oils condensed from the cracked vapors, pass out of the bottom of the exchange tower through line 114 to a storage tank, (not shown). Pump 115 is used to pump the heavy oils to the storage tank. The lighter oils vaporized in the exchange tower together with uncondensed vapors from the cracking tube are conveyed from the top of the tower through pipe 116 to the fractionating tower 117. Fractionating is accomplished in the fractionating tower by air, water or oil cooling and the cooling of the tower is so arranged that only the desired motor fuel remains uncondensed. The uncondensed vapors from the fractionating tower are conveyed through pipe 118 to a final condenser 119 and thence to the receiving house. The vapors condensed in the fractionating tower are conveyed by pipe 120 to vaporizer or still 121 where they are again vaporized. Under usual conditions it is necessary to supply an additional quantity of oil to the vaporizer or still. Pipe 121^a is used to feed the additional fresh supply of oil. This pipe leads to a source of suitable material. Pump 122^a is used to feed this oil to the still. The vapors from the still are conveyed through pipe line 122 to the cracking tube or tubes and thence through the system in the manner similar to that described in connection with the apparatus shown in Figure 5 of the drawings. The advantages of the apparatus shown in Figure 8, when employed in connection with crude oil are that such oil may be stripped of its lighter constituents by the heat of the vapors from the cracking apparatus thereby economizing heat. The heavy stripped oil removed from the fractionating tower through pipe 114 may be utilized in any suitable way. The vaporizer shown in this view is a still similar to still 109 shown in Figure 7 but under some circumstances I may employ in lieu thereof such a special vaporizer as the element 75 of Figure 5.

In all the views valves are provided on the lines permitting control of amounts and direction of flow of oil and vapors. This operation is obvious from the above description.

The yield obtained in the several condensers of course depends largely upon the character of the oil under treatment, greater yields of motor fuel being of course obtainable from kerosene than from heavier oils, such as gas oil and solar oil. With solar oil and gas oil, ordinarily there will be condensed in the primary condenser 70 per cent or so of high boiling oil where gasoline of 400° F. dry point is being made; or about 60 per cent in making a gasoline of 430° dry point. In speaking of these gasolines, I of course mean the refined products obtained by steam treating and stilling the secondary condensates. In the rectification of gasoline in the steam still, a small amount of "heavy ends" is always obtained.

What I claim is:—

1. In the manufacture of low boiling oils from higher boiling oils, the process which comprises vaporizing such a higher boiling oil, passing the vapors through a hot tubular cracking zone at such a rate that only a portion of the vapors are cracked therein, passing the emerging vapors through an air

cooled condenser and in such a condenser scrubbing with high boiling oil, returning the mixture of scrubbing oil and condensed high boiling oil to serve for the production of vapors for the cracking zone, and condensing the residual vapors passing the air cooled condenser to give a condensate of the desired low boiling oils.

2. The process of converting high boiling petroleum hydrocarbons into low boiling petroleum hydrocarbons which comprises passing the vapors of high boiling petroleum hydrocarbon oils through a heated zone at a temperature of about 500° C. and at a rate sufficiently rapid to give a condensate having at least 80 per cent volume of the original oil and containing a substantial proportion of oils as high boiling as those so passed.

3. In the process of making low boiling petroleum hydrocarbons, such as gasoline, benzine, ligroin, and the like from high boiling petroleum hydrocarbons, such as crude petroleum, petroleum distillates, and petroleum residuums, the process which comprises passing the vapors of such high boiling oils through a heated zone at a temperature of about 500° C. at about atmospheric pressure, and at a rate sufficiently rapid to ensure a substantial portion of such vapors passing through unchanged, fractionally condensing the so treated vapors in such manner that the high boiling and unchanged hydrocarbon products are separated from the desired low boiling hydrocarbon product, and continuously returning the high boiling and unchanged hydrocarbon products to be rerun repeatedly through the same cycle of treatment.

In testimony whereof I have hereunto affixed my signature this 23 day of November, 1917.

CLIVE M. ALEXANDER.

3382

F. T. MANLEY.

APPARATUS FOR CRACKING HYDROCARBON OILS.

APPLICATION FILED OCT. 10, 1917.

1,428,338. Patented Sept. 5, 1922.

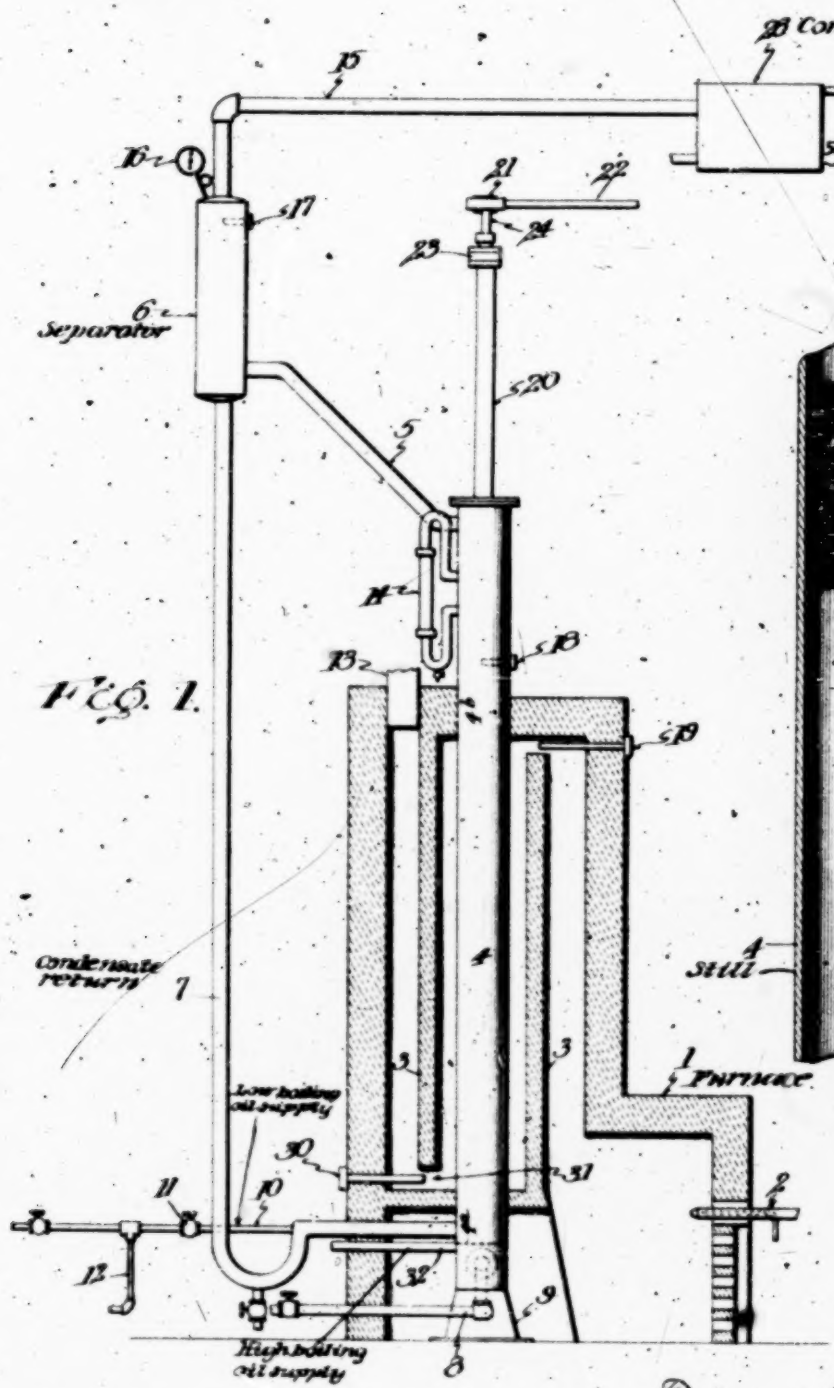

FIG. 1.

FIG. 2.

Witness
C. F. Baker.

Inventor
Frederick T. Manley

By Foster, Freeman, Watson & Coit
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Patented Sept. 5, 1922.

3383

1,428,338

UNITED STATES PATENT OFFICE.

FREDERICK T. MANLEY, OF HOUSTON, TEXAS, ASSIGNOR TO THE TEXAS COMPANY OF NEW YORK, N. Y., A CORPORATION OF TEXAS.

APPARATUS FOR CRACKING HYDROCARBON OILS.

Application filed October 10, 1917. Serial No. 195,774.

To all whom it may concern:

Be it known that I, FREDERICK T. MANLEY, a citizen of the United States, residing in Houston, Harris County, and State of Texas, have invented certain new and useful Improvements in Apparatus for Cracking Hydrocarbon Oils, of which the following is a specification.

The apparatus constituting the subject matter of this application was designed by me as an efficient and convenient means for performing certain novel processes of cracking hydrocarbon oils invented by me and made the subject my separate applications for patents Serial numbers 195,775 and 195,776, filed October 10, 1917, but it is to be understood that this apparatus is not limited in its use to the carrying out of those particular processes. The novel features of construction and the novel methods of operation thereby permitted will be apparent from the following description taken in connection with the accompanying drawing in which—

Figure 1 shows the apparatus partly in vertical section;

Figure 2 is an enlarged section of a portion of the cracking still showing scraping means therein.

Referring to the drawing, a cracking still 4, with suitable supports 9, is heated intermediate its ends in a furnace 1, having a baffle wall 3, burner 2, and stack 13. A vapor line 5, extends from the upper portion of the cracking still above the heating zone to an air condenser 6. A conduit 7, reaches from the air condenser directly to the lower portion of the cracking still below the heating zone in order to return condensed material. 8 is a valved draw-off pipe at the bottom of cracking still 4. The still is preferably equipped with a supply pipe 10 entering the horizontal section of the conduit 7, whereby the introduction of the oil charge is caused to produce an injector effect by which the condensate in the pipe 7 is forced into the bottom of the still. The supply pipe has a check valve 11 of any well known form.

A vapor pipe line 15 extends from the air condenser 6 to a water condenser 28, the outlet from the water condenser 28 being fitted with a valve 29. 16 denotes a pressure gauge on the air condenser to indicate the vapor pressure therein. 17 and 18 designate recording thermometers in the air condenser and cracking still, and 19 and 30 furnace pyrometers. A gauge 14 for indicating the liquid level in the still 4 is situated at the upper part thereof. In this form of apparatus the hydrocarbon oil in the cracking still 4 form an extended vertical column and as the oil charge and condensate is forcibly supplied near the bottom it passes upward through the column and is cracked in its passage.

In order to keep the inner surface of the cracking still clean and prevent the collection of material on that surface I preferably provide the device with scraping means shown in detail in Figure 2. The scraping means includes a shaft 24 extending centrally down into the cracking still and engaging any suitable bearing at the bottom. This shaft carries steel brushes 25, brushes being secured to the shaft by the rods 27, around which are placed coiled springs 26 to yieldingly press the brushes against the inner surface of the still 4. The shaft 24 may be driven through a worm gear 21 from the shaft 22. In order to support the shaft at its upper end I preferably mount a pipe 20 in the upper end of the sill 4 slightly larger in diameter than the shaft 24, and at the upper end of this pipe 20, I place a stuffing box, 23. The purpose of this pipe 20 is to place the stuffing box in a relatively cool position. The brushes in the tube 4 are placed only in the cracking zone which, as illustrated in Figure 1, is between the parts marked 4^a and 4^b.

The heating arrangements of the furnace are such that the hot combustion gases pass upward from the burner 2 between the furnace wall 1, and baffle 3, until they are deflected by the top wall of the furnace into the heating chamber formed by the baffle 3 and in which chamber is the cracking still. The hot gases pass downwardly imparting heat to the cracking still, and find exit at 31 to and through the stack 13. The upper and lower ends of the cracking still preferably extend beyond the heating zone.

As an illustration of the method of use of my apparatus I may charge the still 4 with the hydrocarbon oil which it is desired to crack through pipe 10, the liquid level of the oil being maintained at a point above the heating zone, in the upper portion of the still. The hydrocarbon may be heated to a temperature of from 650° to 800° F. and a

suitable pressure may be maintained by means of valve 29 in the condenser outlet. The temperature and pressure may be varied in accordance with the character of oil treated and of the products desired. I may use a pressure as high as 300 lbs., but ordinarily the pressure used is not below 100 lbs. Vapors generated in still 4 pass directly through vapor line 5 to air condenser 6, where the heavier constituents, ordinarily predominantly of the kerosene type, are condensed, while the lighter constituents, ordinarily predominantly of the gasoline type, pass through vapor line 15 to water condenser 28, and are condensed. The hydrocarbons condensed in air condenser 6 are directly returned for further decomposition through pipe 7 to the bottom of still 4, and are forced into and through the column of hydrocarbon maintained there.

In another method of use of my apparatus I may charge the still with residuum or other heavy hydrocarbon oil through pipe 32 and heat it to produce the desired cracking temperature, which may ordinarily vary from 650° to 800° F. I may then introduce a lighter hydrocarbon oil of lower boiling point, which it is desired to crack, such as kerosene distillate or gas oil, through supply pipe 10, the lighter oil being decomposed in its passage through the heavier oil. The vapors pass from still 4 through vapor line 5 to an air condenser 6, where heavier constituents thereof are condensed, the lighter vapors such as those of the gasoline or naphtha type passing through vapor line 15 to water condenser 28. The hydrocarbons condensed in air condenser 6 flow back through pipe 7 to the bottom of still 4 and are forced through the column of heated hydrocarbon oil maintained therein for further decomposition by an ejector action due to the inward flow of fresh oil through the pipe 10. Any desired pressure may be maintained in the system by manipulation of valve 29 on the condenser

It is readily apparent that my apparatus is adapted for other methods of operation.

What I claim and desire to secure by Letters Patent is:

1. Apparatus for cracking hydrocarbon oils comprising a relatively tall vertical still, means for introducing a heavy oil and maintaining it at a substantially constant level in said still, means for heating the still intermediate its ends to maintain the heavy oil therein at a cracking temperature, a separator connected to receive vapors from the top of the still, a condenser connected to the separator, a liquid return pipe connected directly from the separator to the bottom of the still, and means for forcing the liquid from the return pipe through the body of the heavy oil in the still

2. Apparatus for cracking hydrocarbon oils comprising a relatively full vertical still, means for introducing a high boiling point hydrocarbon oil and maintaining it at a substantially constant level in the still, means for heating the still to maintain the oil at a cracking temperature, a separator connected to receive vapors from the top of the still, a condensate return line connected directly from the separator to the bottom of the still, and means for forcing the condensate from the return line through the body of oil in the still.

3. Apparatus for cracking hydrocarbon oils comprising a relatively tall vertical still, means for introducing a heavy oil and maintaining it at a substantially constant level in said still, means for heating the still intermediate its ends to maintain the heavy oil therein at a cracking temperature, a separator connected to receive vapors from the top of the still, a condenser connected to the separator, a liquid return pipe connected directly from the separator to the bottom of the still, and an inlet connection for forcibly supplying fresh oil into the return pipe near the still to force the liquid from the return pipe with the fresh oil through the body of oil in the still.

4. Apparatus for cracking hydrocarbon oils comprising a still, means for introducing a high boiling point hydrocarbon oil and maintaining it at a substantially constant level in the still, means for heating the still to maintain the oil at a cracking temperature, a separator connected to receive vapors from the top of the still, a liquid return line connected directly from the separator to the bottom of the still, and an inlet connection for forcibly supplying fresh oil into the return pipe near the still to force the liquid from the return pipe with the fresh oil through the body of oil in the still.

5. Apparatus for cracking hydrocarbon oils comprising a still, a charging line at the bottom, a vapor line at the top, a separator to which the vapor line is connected, a liquid return pipe connected directly from the bottom of the separator to the bottom of the still, a second charging line leading into the return line near the still, and discharging thereinto in the direction of flow of oil therethrough, adapted to force the liquid from the return line through the body of oil in the still.

6. Apparatus for cracking hydrocarbon oils comprising an elongated vertical still, means surrounding the still intermediate its ends for subjecting the contents thereof to a cracking temperature, means for introducing oil into the bottom of the still and below the heating zone and maintaining a substantially constant level therein, means connected to the vapor space above the level of the oil in the still for receiving the evolved vapors and separating out the un-

converted portions, means for directly returning said unconverted portions from said separating means to the bottom of the still below the heating zone and for forcing them upwardly through the entire body of the heated oil in the still, and means operated during the cracking operation for removing carbon deposited on the walls of the still and permitting it to gravitate out of the heating zone.

7. Apparatus for cracking hydrocarbon oils comprising an elongated vertical still, a furnace surrounding the still intermediate its ends for imparting a cracking heat thereto, means for receiving the evolved vapors and separating out the unconverted portions, and means directly connecting the separating means and the bottom of the still and including a device located adjacent to lower end of the still and traversed by fresh charging oil for forcibly injecting the separated condensate into the still in conjunction with the fresh oil.

8. Apparatus for cracking hydrocarbon oils comprising a vertical still maintained under pressure, a furnace surrounding the still intermediate its ends for heating the oil therein to a cracking temperature, a pipe for supplying oil under pressure to the bottom of the still, means connected to the vapor space of the still for separating out the heavier constituents of the evolved vapors, and a return pipe directly connected from said separating means to said supply pipe for returning the condensate to the bottom of the still, said return pipe having a U-bend at the point of condenser with said supply pipe.

9. Apparatus for cracking hydrocarbon oils comprising a cracking still maintained under pressure, means for heating the still intermediate its ends to a cracking temperature, a pipe for supplying a stream of charging oil under pressure into the lower end of the still, means for receiving the evolved vapors and separating out the heavier constituents thereof, a return pipe directly connecting the separating means and said supply pipe for returning the condensate to the bottom of the still, and means for positively forcing the condensate into the charging oil traversing said supply pipe.

In testimony whereof I do affix my signature.

FREDERICK T. MANLEY.

3388

F. T. MANLEY.

METHOD OF CRACKING HYDROCARBON OILS.

APPLICATION FILED OCT. 10, 1917.

1,428,339. Patented Sept. 5, 1922.

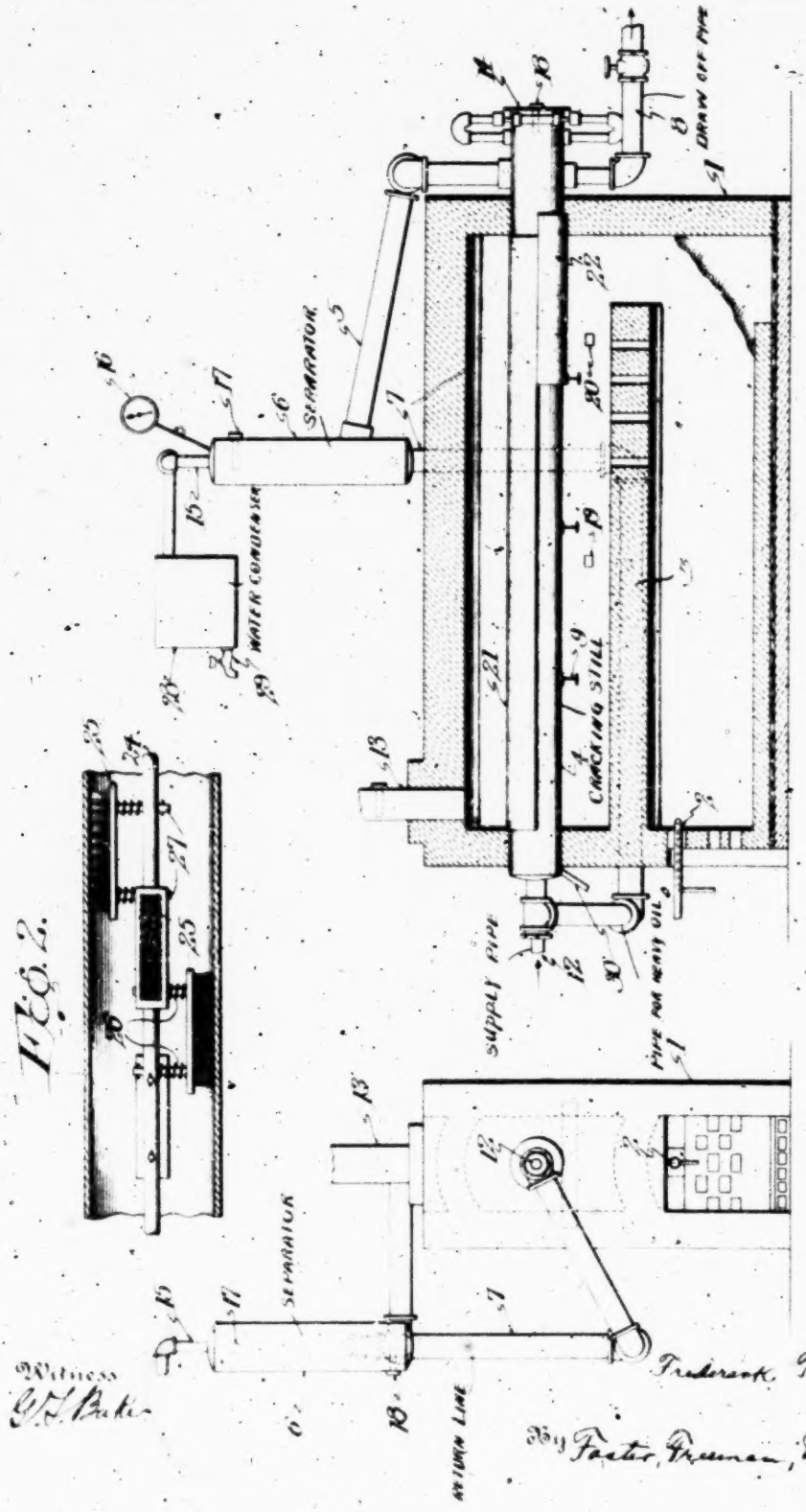

FIG. 1.

FIG. 2.

FIG. 3.

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Patented Sept. 5, 1922. 3389 1,428,339

UNITED STATES PATENT OFFICE.

FREDERICK T. MANLEY, OF HOUSTON, TEXAS, ASSIGNOR TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF TEXAS.

METHOD OF CRACKING HYDROCARBON OILS.

Application filed October 10, 1917. Serial No. 195,777.

To all whom it may concern:

Be it known that I, FREDERICK T. MANLEY, a citizen of the United States, residing at Houston, in the county of Harris and State of Texas, have invented certain new and useful Improvements in Methods of Cracking Hydrocarbon Oils, of which the following is a specification.

This invention relates to novel processes by which higher boiling hydrocarbons are decomposed or broken up into lower-boiling hydrocarbons. It relates especially to the cracking of such oils as kerosene, gas oil, lubricating oil and the like, for the production of more volatile products, such as are usually designated by such terms as naphtha and gasoline.

In the practice of cracking hydrocarbons for the production of these volatile products one difficulty commonly encountered is the construction and maintenance of apparatus capable of withstanding the high pressure usually sought to be employed. It is an object of my invention to minimize this difficulty by the use of suitable heating means whereby a sufficient heat may be maintained in the cracking zone to effect the desired decomposition with a reduction of the usual pressures. It is a further object of my invention to provide a heating zone capable of a combined liquid-vapor phase cracking process and of such a character that there is no local superheating with the consequent large production of fixed gas and carbon.

In general this invention preferably contemplates passing a lower-boiling hydrocarbon through a still charged with a higher-boiling hydrocarbon and heated to a high temperature, and collecting the resulting vapors of desired volatility. I charge a suitable still with one of the higher-boiling hydrocarbons, such as a residuum or one of the heavier distillates of petroleum distillation. I heat the higher-boiling oil and then introduce into the still the lower-boiling hydrocarbon, such as a gas oil or kerosene distillate. The heat in the still vaporizes and cracks the lower-boiling oil and the vaporized and cracked products tend to gather in and pass along the vapor portion of the still where there is maintained a heat sufficient to further decompose the vaporized constituents into more volatile products. The conversion therefore takes place in a combined liquid-vapor phase. By reason of the presence in the still of the higher-boiling oil it is possible to maintain a temperature sufficient to vaporize and decompose the lower-boiling oil without using the excessive pressures which would otherwise be required to obtain the desired decomposition.

My process may be carried out by any suitable means. A form of apparatus by which the herein disclosed process may be successfully operated is illustrated in the accompanying drawing.

For the purpose of fully explaining my process I will describe herein the method pursued when using the apparatus illustrated, but it is to be understood that the use of my process is not confined to said apparatus.

In the drawings:

Figure 1 is a vertical longitudinal section through the device;

Figure 2 is an enlarged section through a modified construction showing scrapers in the cracking still; and

Figure 3 is an end view.

Referring to the drawing, a cracking still 4, preferably of considerable length in comparison with its diameter, is placed horizontally in a furnace 1, having burner 2, baffle wall 3 and stack 13. The cracking still 4 is supported by the walls of the furnace and by T irons 9. At one end of the still 4 is a vapor line 5 extending to an air condenser 6. From the lower part of the air condenser extends a conduit 7 to the other end of the cracking still. A supply pipe 12 enters the tube preferably at one end thereof. 8 is a draw-off pipe. 17 and 18 denote recording thermometers, and 19 and 20 designate furnace pyrometers. 16 is a pressure gauge.

The heating arrangement of the furnace is such that the hot combustion gases are deflected by the baffle 3 to the rear of the furnace where they enter the heating chamber containing the cracking still 4. The hot gases pass along the still imparting heat to the entire periphery thereof, and find exit through the stack 13. The still 4 is provided with an insulated plate 22 which prevents any local overheating which might otherwise occur along that portion of the still near where the furnace gases enter the heating chamber. The upper periphery of the still is covered with a light insulation 21 which enable not only the maintenance of

a high degree of heat in the vapor zone of the still, but a heated zone of even temper with no local overheating.

I preferably charge the still 4 with a residuum or one of the heavier distillates of petroleum distillation through pipe 30 until it is partially filled and heat the still until there is generated therein the desired cracking temperature, which is ordinarily from 650° to 800° F., the exact temperature, of course, depending upon the character of the hydrocarbons used in the operation. When the desired temperature is obtained I introduce, through the supply pipe 12, the lower-boiling hydrocarbon, such as a gas oil or kerosene distillate. The lower-boiling hydrocarbon on coming in contact with the highly heated hydrocarbon body in the still 4 is partially cracked in the liquid phase and partially vaporized and decomposed in the vapor phase. As it passes along the extended cracking still the vaporized and cracked constituents tend to gather in the vapor zone along the upper portion of still 4 above the heavy oil where there is maintained a sufficient heat to further decompose the vaporized constituents into more volatile products. The generated vapors pass out of the cracking still through the vapor conduit 5 to the air condenser 6 from which the gasoline or naphtha constituents are conducted by the pipe 15 to the water condenser 28 provided with outlet valve 29 by which the pressure in the apparatus may be controlled. The less volatile constituents in the air condenser 6 are returned to the cracking still by the conduit 7 and are forced through the cracking still by the injector effect of the ingoing oil which is continuously charged into the cracking still through pipe 12. The gasoline or naphtha constituents are continuously passing through the vapor line and separator into the water condenser and are withdrawn continuously from the outlet 29.

I also maintain the supply of the higher boiling oil in still 4 by continuously or intermittently feeding such oil in through pipe 30. The vaporized products which pass to the air condenser 6 and which are not of sufficient volatility for the gasoline or naphtha desired, are continuously condensed therein and returned to the still and repass through the extended and combined liquid vapor cracking zone.

As a more specific example of my process I may use as the higher boiling oil a residuum having a gravity of 26° Baumé, a flash point of 265 and a distillating point of 445 (as tested in the ordinary Engler distilling flask). I charge the still 4 with this residuum and apply heat thereto until distillation begins, the temperature of the oil at this point being 700° F., as denoted by the thermometer 18. The lower boiling oil, which may be a distillate from which all of the light products, such as gasoline of naphtha, have been removed, and which has a Baumé gravity of 39°, a flash point of 190 and a distilling point of 354, is then introduced into the still. The valve controlled outlet 29 is so regulated that a sufficient pressure is constantly maintained on the apparatus. The distillate on coming in contact with the highly heated body of oil under this pressure is partially decomposed and partially vaporised and then decomposed. The distillate is continuously supplied to the still and from time to time fresh residuum is added. The residue formed, containing carbon and asphaltic bodies, is drawn off through the outlet 8.

The cracking still 4 may be provided with rotary means for removing any carbon or other deposit on the interior surface of the still, the rotary scraping means being mounted and arranged substantially as disclosed in my co-pending application, Serial Number 195,774 filed of even date herewith. The scraping means is shown in Figure 2, where the rotary shaft 24 extends axially into the still 4 from one end and turns in a bearing in said still at the other end. At the entrance end the still 4 is provided with a projecting pipe of smaller diameter through which the shaft 24 passes and at the outer end of which there is a stuffing box and bearing removed from the point of high heat. The shaft 24 carries steel brushes 25 supported on rods 27 and pushed outward by coiled springs 26. These brushes are placed only along that portion of the still 4 receiving the high cracking heat.

In the operation of the herein disclosed process I construct the cracking still 4 of considerable length, as from 25 to 50 feet long. The object of this is to form a heating zone of such extent that the lower-boiling oil will be heated sufficiently to thoroughly vaporize and decompose it into volatile constituents and to reduce to a minimum the passage from the cracking still of products less volatile than desired. There is, however, usually a considerable quantity of constituents which, although less volatile than gasoline or naphtha, are yet so readily vaporized that they tend to pass out from the heating zone so rapidly that they will not be decomposed into products of the desired volatility. The decomposition of these products is effected by returning them after condensation to the cracking still through pipe 7 and continuously forcing them through the extended heating zone.

Without the insulation 21 the vapor portion of the still, by reason of the greater ability of the oil vapors to absorb heat, would attain a temperature considerably higher than the liquid portion, thereby causing the vapors to be overheated and result-

ing in the formation of a product containing a large proportion of unsaturated compounds. By means of the insulation 21, the rate of conduction of heat through the vapor zone is reduced so that both the liquid and the vapor portions are maintained at substantially the same temperature, thereby creating a combined liquid-vapor cracking zone of such a character that while a heat sufficient for decomposition is maintained, it is an even-tempered heat with no local overheating. The hydrocarbons passing through this extended, even tempered, cracking zone are effectually decomposed into products of the desired volatility.

Attention is directed to the fact that there is a time element necessary to the effective and complete cracking of hydrocarbon oils into a lighter product such as gasoline. It is consequently desirable to keep the oil such as kerosene or gas oil which is to be converted into gasoline or the like, at a cracking temperature for a considerable length of time.

This result, according to the process of my present invention, is accomplished by providing an elongated cracking zone through which the kerosene or the like must necessarily pass either in liquid or in vapor form before it can escape into the vapor line.

This long zone is maintained at a substantially constant temperature by partially filling it, about half full for example, with heavy hydrocarbon residue or the like, which is maintained at a cracking temperature and by insulating the vapor space to prevent the temperature from becoming excessive.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:—

1. The continuous process of cracking hydrocarbon oils of comparatively low boiling points which consists in bringing said oils in contact with a horizontally elongated body of higher boiling point hydrocarbon oil maintained at a temperature sufficient to cause vaporization and decomposition of said lower boiling oil, causing the vapors generated to pass along in contact with the elongated surface of said heated higher boiling point oil and preventing overheating of said vapors during said passage to maintain a substantially uniform temperature of sufficient intensity to continue the cracking of the vapors.

2. The continuous process of cracking hydrocarbon oils of comparatively low boiling point which consists in bringing said oils in contact with a horizontally elongated body of higher boiling point hydrocarbon oil maintained at a temperature sufficient to cause vaporization and decomposition of said lower boiling oil, causing the vapors generated to pass along the elongated surface of said heated higher boiling point oil progressively throughout the length of an elongated heating zone and preventing overheating of said vapors during the passage through said heating zone, to maintain them at a substantially uniform cracking temperature.

3. The continuous process of cracking hydrocarbon oils of comparatively low boiling points, that consists in maintaining a horizontally elongated body of high boiling hydrocarbon oils at a cracking temperature and maintaining an elongated vapor space above said liquid body at a substantially uniform cracking temperature and forcing said comparatively low boiling point oil through the elongated cracking zone, consisting of said liquid body and vapor space and condensing the vapors after they have passed through said zone.

4. The continuous process of cracking hydrocarbon oils of comparatively low boiling points, that consists in maintaining a horizontally elongated body of high boiling hydrocarbon oils at a cracking temperature and maintaining an elongated vapor space above said liquid body at a substantially uniform cracking temperature, introducing at one end said comparatively low boiling point oils into the cracking zone, consisting of said liquid body and vapor space, withdrawing vapors from the opposite end of said zone, separating uncracked oils from said vapors, and returning them to the charging end of the cracking zone.

5. The continuous process of cracking hydro-carbon oils of comparatively low boiling point, which comprises delivering said oils to one end of a horizontally elongated liquid-vapor cracking zone, maintaining both liquid and vapor spaces of the cracking zone at a substantially uniform cracking temperature, and passing the oils throughout the entire length of the cracking zone whereby they are cracked in a combined liquid-vapor phase.

6. The continuous process of cracking hydro-carbon oils of comparatively low boiling point, which comprises maintaining the liquid and vapor spaces of a horizontally elongated liquid-vapor cracking zone at a substantially uniform cracking temperature, delivering the oils into one end of the cracking zone whereby they are cracked in a combined liquid vapor phase, and withdrawing the evolved vapors from the other end of the cracking zone.

7. The continuous process of cracking hydro-carbon oils of comparatively low boiling point, which comprises subjecting the liquid and vapor spaces of a horizontally elongated cracking zone to substantially uniform cracking temperatures, passing the oils throughout the entire length of the cracking zone whereby a portion of the oil is converted in the liquid phase and a por-

tion thereof vaporized and converted in the vapor phase, withdrawing the evolved vapors from the farther end of the cracking zone, separating out the unconverted portions of the evolved vapor and returning them to the cracking zone for re-treatment.

8. The continuous process of cracking hydro-carbon oils of comparatively low boiling point, which comprises subjecting to cracking heats the entire periphery of an elongated horizontal cracking still throughout its length, the still being partially filled with oil and having a vapor space above the level of the oil therein, heat-insulating the vapor space of the still to establish substantially uniform cracking temperatures in the liquid and vapor spaces of the still, introducing the oils to be converted into one end of the still, and withdrawing the evolved vapors from the other end thereof, whereby the oils are cracked in a combined liquid-vapor phase in transit through the still.

10. The continuous process of cracking hydro-carbon oils of comparatively low boiling point, which comprises heating an elongated horizontal still having a vapor space above the level of the oil therein so that both its upper and lower potions are maintained at a substantially uniform cracking temperature, passing the oil to be converted through the still whereby it is cracked, partially in the liquid phase and partially in the vapor phase, and creating a cyclic circulation through the cracking zone to cause the unconverted constituents of the vapor evolved to be repassed through the still and repeatedly subjected to cracking conditions.

10. The continuous process of cracking hydro-carbon oils which consists in passing a lower boiling oil through a cracking zone comprising a lower liquid portion and an upper vapor portion, the liquid portion being composed of a higher boiling oil maintained at a temperature sufficient to decompose said lower boiling oil and both liquid and vapor portions being heated externally, the rate of heat conduction to the vapor portion being less than that to the liquid portion so that substantially the same temperature is maintained in the vapor and liquid portions of the cracking zone.

11. The continuous process of cracking hydro-carbon oil which consists in passing lower boiling oil through a cracking zone comprising a lower liquid portion and an upper vapor portion, and applying heat to the cracking zone under such conditions as to maintain a substantially uniform cracking temperature in both the liquid and vapor portions thereof.

In testimony whereof I affix my signature.

FREDERICK T. MANLEY.

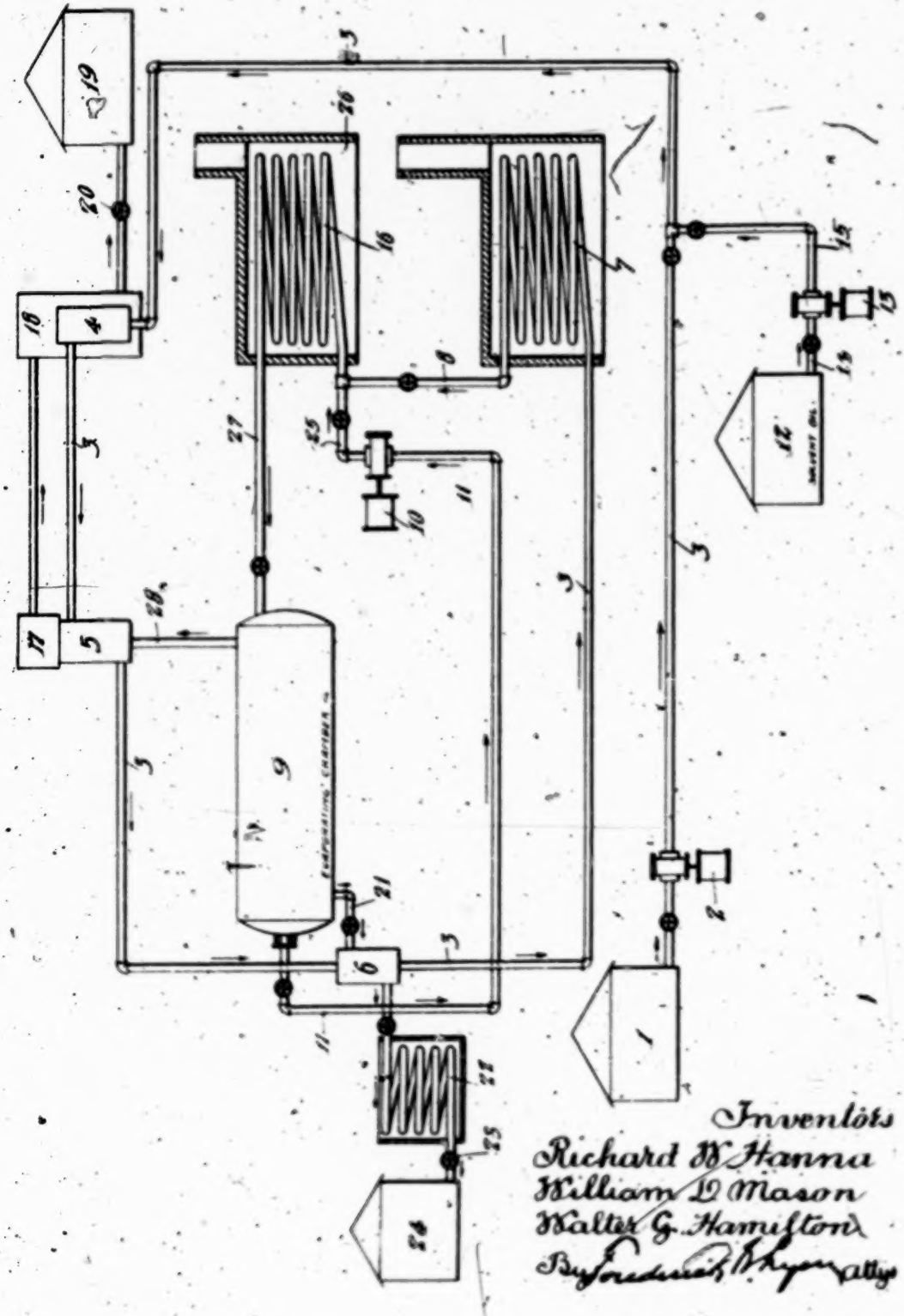
3,394

Mar. 20, 1923. 1,449,226.

R. W. HANNA ET AL.

PROCESS OF CRACKING HYDROCARBON OILS UNDER PRESSURE TO PRODUCE A LOW BOILING POINT FRACTION FROM A HIGHER BOILING POINT OIL OR FRACTION

FILED AUG. 29, 1921.



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Patented Mar. 20, 1923. 3395 1,449,226

UNITED STATES PATENT OFFICE.

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PROCESS OF CRACKING HYDROCARBON OILS UNDER PRESSURE TO PRODUCE A LOW-BOILING-POINT FRACTION FROM A HIGHER-BOILING-POINT OIL OR FRACTION.

Application filed August 29, 1921. Serial No. 496,403.

To all whom it may concern:

Be it known that we, RICHARD W. HANNA, WILLIAM D. MASON, and WALTER G. HAMILTON, citizens of the United States of America, residing at Richmond, Contra Costa County, State of California, have invented a new and useful Process of Cracking Hydrocarbon Oils Under Pressure to Produce a Low-Boiling-Point Fraction from a Higher-Boiling-Point Oil or Fraction, of which the following is a specification.

This invention relates to the art of cracking hydrocarbon oils under pressure to produce a low boiling point fraction from a higher boiling point oil or fraction.

In the cracking, under pressure, of a high boiling point oil or distillate to produce naphtha or other low boiling point fraction, it has been the common practice to charge the oil to be cracked into the still or cracking system, cold, (i. e., at normal temperature or slightly heated) and then bring the entire "charge" up to the temperature and pressure of the required cracking operation. In some adaptations of such process, some additional "charging stock" or oil to be cracked has been fed into the apparatus by feeding the same either into the vapor line, reflux apparatus, or directly into the still or system. This additional charging stock has been so introduced "cold", i. e., either at normal temperature, or slightly heated by vapor heat exchangers as a fuel economy. The still or heating coil has been subjected to heat in degree and amount sufficient to raise the whole body of oil to and maintain it at the cracking temperature. This has resulted in the heating element or unit being subjected to such a high degree and amount of heat as to cause very rapid deterioration of such heating element or unit, in order to heat all the oil to the temperature of the cracking operation. Portions of the oil have necessarily been abruptly subjected to much more intense heat than required in the cracking operation, thereby causing excessive cracking of portions of the oil and the production of excessive amounts of gas and heavy bodies, tar, carbon, etc.

Heretofore very material portions of the oil, (and in some processes all of the oil as it was subjected to the cracking operation, have been abruptly subjected to excessive raises in temperature causing excessive cracking resulting in the production of excessive amounts of gas and of heavy bodies, tar, carbon, etc., with a resultant loss in the yield of the desired low boiling point product and the production of large amounts of unsaturated hydrocarbons.

We propose to bring the entire body of the oil, to be subjected to the cracking operation, to the required cracking temperature without subjecting any portion thereof to an abrupt or to an excessive raise in temperature thereby avoiding such excessive cracking and thereby subjecting all the oil to an even and uniform cracking distillation.

To this end we provide for a primary or preparatory heating of the charging stock before introducing it into the cracking unit or system.

This primary heating is to such a temperature as will enable us to introduce the oil at such temperature into the cracking unit, or system and there raise it to and maintain it at the temperature of the cracking operation without the necessity at any time during the process of subjecting any part of the oil to either an excessive temperautre or to too abrupt raise in temperature.

Preferably such primary heating is given to the oil as it is being fed to the cracking apparatus or system. While such primary heating is preferably produced by raising the temperature of the oil as it progresses toward the cracking system evenly through the body of the oil; it is also preferable that such primary heating be affected in comparatively short time, and preferably immediately before passing the oil into the cracking temperature as thereby polymerization is decreased. Polymerization is to be avoided as far as possible as the polymerized portions decompose most readily and break down to an excessive degree producing gas and heavy bodies, thus causing material losses in volume of yield, quality of yield, and excessive production of heavy residual bodies.

This primary heating may be wholly or partially accomplished in various ways, as

for example, waste heats of the refinery (such as the heat from vapor heat exchangers, refluxing condenser apparatus, and the like,) may be utilized to partially raise the temperature of the charging stock and such partially heated charging stock then passed into a primary heater, in the form of a still or coil, directly or indirectly heated, wherein it may be raised to such desired temperature, or from such waste heat exchangers, etc., the charging stock may be conducted through heating devices arranged to be heated by the waste heat of stacks, finally conducted through such a primary heater, still or coil to bring such oil to such desired temperature. As this charging stock is necessarily a distillate, or mixture of distillates, it will possess a material range of boiling points all relatively higher than the low boiling point product desired. We take a charging stock, therefore, with a material range of boiling points; to wit, of not less than 200° F., and in the primary heating keep such stock under such a pressure as to at all times during such primary heating prevent vaporization of any material portion of the charging stock whereby substantially all the charging stock is at all times during such primary heating retained in liquid form and cracking thereof substantially avoided.

Preferably, we force the charging stock into and through the primary heating means under pressure so that a pressure in excess of the pressure maintained during the cracking operation is maintained on the charging stock during the primary heating. Vaporization of any material portion of the charging stock during primary heating is thereby prevented.

In the preferred embodiment of our invention in a process of cracking under pressure we use a charging stock composed of the high boiling point oil or fraction to be cracked and a relatively lower boiling point distillate, fraction or oil, (termed by us "solvent" oil.) which will be substantially unaffected at the temperature and pressure of the cracking operation and which is a higher boiling point oil than the product to be produced. This charging stock we subject to such primary heating to bring the temperature thereof to such an approximation of the temperature of the desired cracking operation that the additional heating required for the heat necessary for the decomposition and the resultant vaporization should not be so intense as to cause that portion of the charging stock which comes into contact with the metal surface of the heating element to be excessively decomposed. This primary heating may be to a temperature just below that of the temperature of the cracking operation so that the heat transfer from the heating element of the cracking system proper to the primarily heated oil when introduced thereinto need not be greater than the heat necessary to supply the heat of the reaction, vaporization, refluxing and radiation losses; but such primary heating must be to a higher temperature than can be effected by utilizing the waste heat of the cracking operation, such as by vapor or residual oil heat exchangers, etc., and must therefore be secured by a source of heat supply extraneous to the main cracking system. If by such primary heating the charging stock is raised to a temperature of substantially 500° F. without material vaporization and introduced into the cracking system or unit at such temperature we have found that a much more even cracking operation can be maintained; that such incoming charging stock can be then raised to and maintained at the cracking temperature with much less danger of excessive cracking of any portion thereof; that the yield of the low boiling point vapor is increased; the capacity of the cracking unit or system increased; a greater rate of distillation may be maintained; and the destructive action upon the cracking apparatus or system may be materially decreased, and that the nearer such primary heating approximates the critical temperature of the cracking operation the more each of the benefits and advantages are increased.

As an example, an oil easily cracked such as heavy lubricating oil fractions of a California crude oil, distilled off under conditions of high vacuum, over a residuum producing a 70 penetration asphaltum, will show incipient cracking at a temperature of 500° F. and quite active decomposition at a temperature of 550° F. With fractions of such characteristics it is undesirable to carry the primary heating to a temperature above 500° F.

When our invention is to be embodied in a process of pressure distillation to produce a substantially uniform low boiling point fraction from a higher boiling point oil or fraction, in the preferred embodiment of our invention, we take the said charging stock which has been so primarily heated and continuously circulate the same through a closed system, maintaining in the system a substantially uniform temperature and pressure, providing means whereby such primarily heated charging stock as it is introduced to the system shall be brought to the temperature of the system, continuously withdraw the low boiling point vapor as produced, and by dilution by constantly feeding into the system additional primarily heated charging stock and by discharge of the heavy bodies resultant from the cracking in solution with the solvent oil of the charging stock, keep a substantially con-

stant volume in the system and keep the circulating oil or menstrum from becoming sufficiently concentrated to cause deposition in the system.

While our invention is not dependent upon any particular form or construction of apparatus it may be more fully and readily comprehended in connection with a system and apparatus by which it may be performed. We have therefore shown and illustrated in the accompanying drawings a diagrammatic view of a system and apparatus in which a preferred embodiment of a process employing our invention may be performed. In such drawing 1 indicates a storage vessel for the high boiling point oil which is to be cracked, 2 a suitable pump designed to pump such oil from the storage 1 and force the same through a pipe or conduit 3. 12 indicates a storage vessel for the solvent oil which is to be mixed with the high boiling point oil to be cracked, for the purpose of taking into solution the heavy bodies produced by cracking such high boiling point oil and prevent such heavy bodies from being so reduced as to cause deposition in the system. Such "solvent" oil may be any lower boiling point fraction of the same oil, of which the oil to be cracked is a part, or of any other oil provided, however, that such "solvent" oil shall be substantially unaffected at the pressure and temperature employed in the cracking of the particular oil operated upon. It is also understood that the preferred embodiment of our process is not limited to the use of any particular non-crackable or "solvent" oil either produced in the system or added from any outside source but may be merely a relatively low boiling point fraction of the oil, cracking of the high boiling point fraction whereof is to be performed. 13 indicates a pump adapted to draw solvent oil through the pipe 14 from the vessel 12 and force it through a pipe or conduit 15 into the pipe or conduit 3 where it is mixed with the oil to be cracked. It is obvious that mixing of the oil to be cracked and solvent oil may take place before the same are supplied to the storage or supply tanks or vessels of the systems in which case such mixtures may be drawn directly from one tank or vessel and forced through a pipe or conduit 3. From the pipe or conduit 3 this charging stock is forced into and through a waste heat exchanger 4 at the condenser 18 and thence through a continuation of such pipe or conduit 3 through a heat exchanger 5 where such charging stock is subjected to the waste heat of the reflux condenser. From such heat exchanger 5 the conduit 3 is preferably carried to a waste heat exchanger 6 at the discharge or withdrawal of the hot residual solution of the system. From this heat exchanger 6 the charging stock is forced through a continuation of the conduit 3 into and through a heating coil 7. This heating coil may be of the ordinary or any preferred construction and fired or heated in any preferred manner. By means of this coil the charging stock is brought to the desired temperature for introduction into the cracking system. Such desired temperature is necessarily higher than any temperature to which the charging stock could be raised by mere waste heat of vapor heat exchangers. From the heating unit or coil 7 a pipe or conduit 8 leads into the heating coil of the cracking system. While we prefer to introduce the primarily heated charging stock into such heating coil it may be introduced at any other desired point in the system.

The cracking apparatus or system proper is indicated as consisting of a suitable vaporizing chamber or evaporator 9 which may be of the ordinary or any preferred construction. 10 represents a pump connecting on its suction side by means of a pipe 11 with the vaporizing chamber or evaporator 9 and on its discharge side with a pipe 25 leading to the heating element or coil 16 of the cracking system. This heating element or coil 16 is preferably mounted in a suitable furnace 26 where it is either directly or indirectly heated as preferred. The coil or heating element 16 is connected by means of a pipe or conduit 27 with the vaporizing chamber or evaporator 9. 28 represents the vapor line from the evaporator 9. 17 is a dephlegmator or reflux condensing apparatus in said line 28 and 18 is a condenser connected with said dephlegmator. 19 indicates a receiver connected with the condenser and 20 is a valve where pressure is released and the condensate delivered to storage. 21 is a discharge pipe from the evaporator 9. 22 is a cooler to which the pipe 21 leads, through the waste heat exchanger 6. 23 is a discharge valve from the cooler and 24 is a receiver. The pump 2 affords a means by which any desired pressure may be placed and maintained upon the charging stock as it is being primarily heated.

The presence in the charging stock of a fraction of oil of lower boiling point than the oil to be cracked, which lower boiling point fraction is substantially unaffected at the temperature and pressure of the cracking operation, provides a medium by which the heavier bodies produced from the cracking of the oil may be carried in solution and prevented from being reduced so heavy or so near to tar or carbon as to cause deposition in the system. In other words, this solvent oil immediately takes and holds in solution the relatively higher boiling point oil or

fraction produced by the cracking, so that it may be discharged from the apparatus. Upon the cracking of the crackable oil into such relatively high and low boiling point fractions this solvent oil immediately takes into solution and holds such higher boiling point fractions from further reduction to tar or carbon. If this solvent oil solution is permitted to become overcharged deposition in the system takes place as these higher boiling point fractions, heavy hydrocarbons tarry or carbonaceous bodies take the brunt of the heat and unless held in solution by the solvent oil become further reduced towards tar or carbon. The degree of concentration, (of the solvent oil and high boiling point fractions produced by the cracking of the crackable oil,) which may be permitted in the system without danger of deposition will, of course, depend upon the oils charged into the system as; for example, the carbon residue test should not exceed ten times that of the charged oils. This is merely an example and will vary with the oils.

In the cracking of certain petroleum distillates there may be produced from the operation sufficient solvent or non-crackable oil of unsaturated form to keep the solid hydrocarbons, tarry residues or higher boiling point fractions in solution so that no deposit will form on the metal surface of the heated element, in which case it is unnecessary to add a solvent or non-crackable oil from an outside source. A certain amount of non-crackable or solvent oil passes off with the solid hydrocarbons, tarry residues, or higher boiling point fractions in solution. This may be replaced from storage as needed.

As an example of the proportion of oil to be charged with a solvent oil, we add one volume of the former to as much as three or five volumes of the latter in the system at any moment; and as an example of a desirable cracking pressure and temperature of the oil to be cracked we give 105 to 120 pounds absolute and 745 degrees to 800 degrees F., but it is to be understood that these proportions and the pressure and temperature may vary according to the oils used.

By thus primarily heating the charging stock we are enabled to most materially reduce the heat demand upon the heating element of the cracking system proper which, therefore, need not be greater than to supply the heat of the reaction, vaporization, refluxing and radiation losses thereby eliminating excessive cracking of portions of the oil, reducing essentially the quantity of fixed gas produced and the resultant quantities of higher boiling point fractions, tarry and carbonaceous residues, minimize the destructive action upon the heating element, increase the vaporizing capacity of the system, decrease the heat transfer per unit area of the cracking element required in the cracking operation proper and are enabled to produce a much more uniform product of the desired low boiling point and at decreased cost. Excessive cracking of a portion of the oil has a very detrimental effect on the quality of the low boiling point product as it results in the production of highly unsaturated hydrocarbons, and by avoiding such excessive cracking we are thus enabled to produce a better and more valuable product.

It is thus seen that the primary heating of our invention comprehends the reduction of the heat demand upon the heating element of the cracking system proper to the end that the amount of heat to be supplied to the oil by such heating element shall be reduced to approximately a minimum, and that the total heat demand of the cracking operation shall be divided up so that the demand upon any given heating element shall not be sufficiently great to require an excessive heat transfer through any such heating element to the oil. By eliminating the requirement of excessive heat transfer through the respective heating elements to the oil abrupt raises in temperature and excessive cracking of portions of the oil may be substantially avoided. For example, with certain oils the following conditions have been noted:

We have found that forty per cent of the heat required to be supplied to the oil is to bring the oil to the temperature of the cracking reaction and that approximately sixty per cent of the heat demand is to furnish the heat of the reaction, volatilization, refluxing, radiation losses, etc. Therefore, by supplying these independently of each other by separate and distinct sources of heat supply the demand of heat transfer can be so controlled that at no point in the operation or system must such a high temperature be supplied as to cause abrupt raise in temperature or excessive cracking.

As illustrative of one of the values of our subjecting the charging stock to such a primary heating before it is introduced into the cracking system we have found that where the charging stock is so introduced at normal temperature an external temperature of approximately 2600° F. is required upon the cracking element or coil; when so primarily heated to a temperature of 500° F. an external temperature upon the cracking unit or coil of approximately 2000° F. is sufficient; with primary heating of the charging stock to 600° F. an external temperature on such cracking coil of 1800° F., and where the primary heating of the charging stock is carried to 700 degrees F. an external temperature of 1000°–1600° F., is sufficient. It will thus be seen that by such primary heating we are enabled to bring substantially the entire body of the oil be-

ing cracked to the required cracking temperature and subject it to the cracking operation without subjecting any material portion thereof to too abrupt or too excessive raise in temperature and that we are thereby enabled to secure a very even and uniform cracking distillation.

We claim:

1. A continuous cracking process consisting in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating the oil is brought approximately to the active cracking reaction temperature of the higher boiling fractions of the oil, a material portion of the heat necessary to raise the oil to such temperature being supplied by heating means independent of the heating means of the cracking system proper, then passing such heated liquid into a cracking system, which includes a heating zone, vaporizing chamber and condenser maintained under pressure, whereby the primarily heated oil is subjected to a higher temperature, the oil flowing through the heating zone being subjected in said heating zone to only such a degree of heat as will furnish the heat of reaction and offset heat losses from radiation, vaporization and reflux condensation, thereby through the medium of the aforesaid primary heating avoiding the exposure of any portion of the oil to excessive local temperatures and resultant excessive cracking and carbon deposit in any portion of the heating zone of the cracking system, and then passing the oil so heated in said heating zone to the evaporating chamber of the cracking system.

2. A continuous cracking process consisting in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, said pressure being in excess of the pressure of the cracking operation proper, in which primary heating the oil is brought approximately to the active cracking reaction temperature of the higher boiling fractions of the oil, a material portion of the heat necessary to raise the oil to such temperature being supplied by heating means independent of the heating means of the cracking system proper, then passing such heated liquid into a cracking system, which includes a heating zone, vaporizing chamber and condenser maintained under pressure, whereby the primarily heated oil is subjected to a higher temperature, the oil flowing through the heating zone being subjected in said heating zone to only such a degree of heat as will furnish the heat of reaction and offset heat losses from radiation, vaporization and reflux condensation, thereby through the medium of the aforesaid primary heating avoiding the exposure of any portion of the oil to excessive local temperatures and resultant excessive cracking and carbon deposit in any portion of the heating zone of the cracking system, and then passing the oil so heated in said heating zone to the evaporating chamber of the cracking system.

3. A continuous cracking process consisting in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof and not less than 500° F., while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating the oil is brought approximately to the active cracking reaction temperature of the higher boiling fractions of the oil, a material portion of the heat necessary to raise the oil to such temperature being supplied by heating means independent of the heating means of the cracking system proper, then passing such heated liquid into a cracking system, which includes a heating zone, vaporizing chamber and condenser maintained under pressure, whereby the primarily heated oil is subjected to a higher temperature, the oil flowing through the heating zone being subjected in said heating zone to only such a degree of heat as will furnish the heat of reaction and offset heat losses from radiation, vaporization and reflux condensation, thereby through the medium of the aforesaid primary heating avoiding the exposure of any portion of the oil to excessive local temperatures and resultant excessive cracking and carbon deposit in any portion of the heating zone of the cracking system, and then passing the oil so heated in said heating zone to the evaporating chamber of the cracking system.

4. The continuous process of cracking which consists in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating a material portion of the sensible heat necessary to raise the oil to the cracking temperature is supplied by means including a heat supply independent of the heat supply of the cracking system proper, and in which primary heating the oil is brought approximately to the temperature of the active cracking reaction of the higher boil-

ing point portions of the oil, passing such primarily heated stock into a cracking system, which includes a heating zone, a vaporizing chamber and condensing equipment and wherein it is continuously circulated and subjected to a substantially constant cracking temperature and pressure and in the heating zone of which only the necessary heat is furnished thereto to supply the heat of reaction and to offset heat losses from vaporization, refluxing and radiation and from which it is passed to the vaporizing chamber, whereby by such primary heating the subjection of any portion of the oil to excessive local temperature in the heating zone or excessive cracking thereof therein is substantially avoided, continuously withdrawing the low boiling point vapor as produced, continuously discharging from the system high boiling point products of such cracking, and continuously feeding into the said system additional primarily heated charging stock.

5. The process of cracking a hydrocarbon distillate to produce a substantially uniform low boiling point oil which consists in primarily heating a moving body of petroleum above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating a material portion of the sensible heat necessary to raise the oil to the cracking temperature is supplied by means including a heat supply independent of the heat supply of the cracking system proper, and in which primary heating the oil is brought approximately to the temperature of the active cracking reaction of the higher boiling point portions of the oil, such oil so primarily heated comprising a high boiling point oil or fraction to be cracked and a solvent oil of lower boiling point which is substantially unaffected at the temperature and pressure of the cracking operation, and then passing such primarily heated oil into a cracking system which includes a heating zone, a vaporizing chamber, and condensing equipment, and wherein it is continuously circulated at a substantially constant pressure and temperature and in the heating zone of which only the necessary heat is furnished thereto to supply the heat of reaction, and to offset heat losses from vaporization, refluxing and radiation, and from which heating zone such oil is passed to the evaporating chamber, whereby by such primary heating the subjection of any portion of the oil to excessive local temperature in the heating zone or excessive cracking of any portion thereof therein is substantially avoided, and whereby such high boiling point oil is cracked, continuously withdrawing the low boiling point vapor as produced, continuously discharging from the system high boiling point products of such cracking in solution, and continuously feeding into said system such primarily heated oil to maintain a substantially constant volume therein.

Signed at Richmond, California, this 12th day of August, 1921.

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WALTER G. HAMILTON.

Witnesses:
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3402

Mar. 20, 1923. 1,449,227.

R. W. HANNA ET AL.

PROCESS OF CRACKING HYDROCARBON OILS UNDER PRESSURE.

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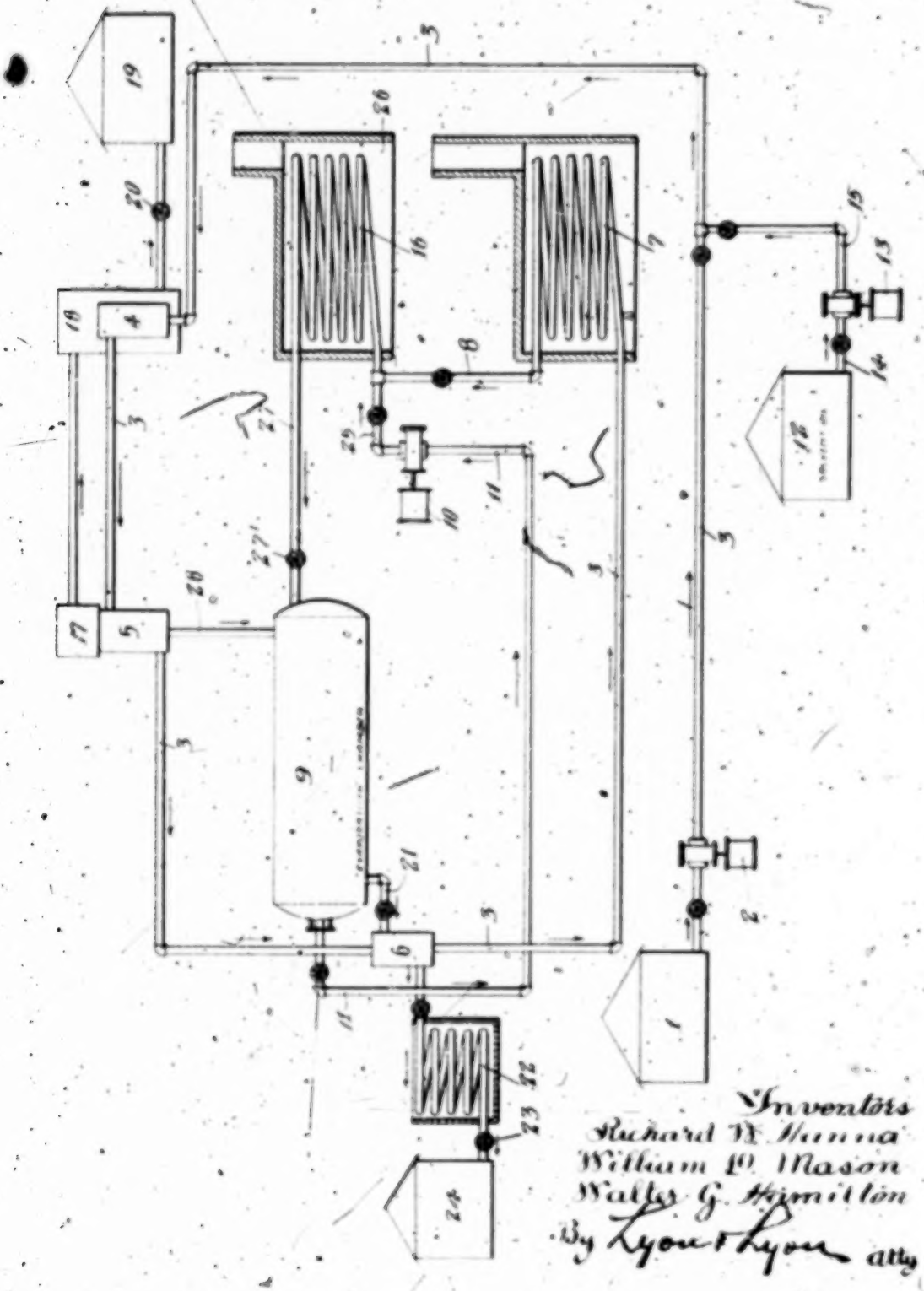

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Patented Mar. 20, 1923.

3403 1,449,227

UNITED STATES PATENT OFFICE.

RICHARD W. HANNA, WILLIAM D. MASON, AND WALTER G. HAMILTON, OF RICHMOND, CALIFORNIA, ASSIGNORS TO STANDARD OIL COMPANY, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF CALIFORNIA.

PROCESS OF CRACKING HYDROCARBON OILS UNDER PRESSURE.

Application filed September 20, 1921. Serial No. 502,031.

To all whom it may concern:

Be it known that we, RICHARD W. HANNA, WILLIAM D. MASON, and WALTER G. HAMILTON, residents of Richmond, in the county of Contra Costa, State of California, citizens of the United States of America, have invented an Improved Process of Cracking Hydrocarbon Oils Under Pressure, of which the following is a specification.

This invention relates to the decomposing or "cracking" of hydrocarbon oil to produce a lower boiling point oil from a relatively higher boiling point oil or fraction.

In the cracking of petroleum oil it has heretofore been the practice either (1) to introduce the oil to be treated cold into a still and then by the application of heat to the still raise the mass or body of oil therein to the required temperature and pressure, or (2) to pass the oil over a surface heated to excessive temperature, or (3) to subject a relatively small volume or stream of the oil to be treated to an excessive temperature in a heated coil or conduit. With each of these all or very substantial and material portions of the oil are subjected to abrupt raises to excessive temperatures and are excessively cracked or broken down, thereby producing an excessive amount of fixed gas, excessive polymerization, the production of large percentage of unsaturated hydrocarbons, tar and heavy residues, and result in rapid deterioration of the apparatus, waste of oil, and the production of a product containing a high percentage of unsaturated hydrocarbons.

We have discovered that by continuously maintaining the oil while it is being treated at substantially the temperature of the cracking operation, a much more uniform cracking action can be secured, that the degree of cracking or decomposition can be regulated and controlled substantially as desired to produce the desired product; and that this will be accompanied with the production of a minimum of fixed gas, a minimum polymerization of the residual oil or resultant high boiling point residues, and that a much more uniform product will be produced containing a minimum of unsaturated hydrocarbons resultant from the cracking. We secure this result by providing an evaporating chamber in which the oil to be treated is maintained at the temperature and pressure of the desired cracking operation. From this evaporating chamber we provide a circulating means by which a stream of oil is constantly taken from the evaporating chamber and circulated through a heating zone, for instance a heating coil or apparatus, and delivered back into the body of oil in the vaporizing chamber so that substantially all portions of the body of oil being treated are repeatedly circulated from such evaporating chamber to and through the heating zone and back into the body of oil in the evaporating chamber. By providing such a circulation of the oil from the evaporating chamber through the heating zone and back into the body of oil in the evaporating chamber in such volume or at such rate of flow that the entire body of oil in the apparatus or system is subjected to such reheating at intervals of approximately ten minutes, we are enabled to maintain the body of oil in the evaporating chamber at a substantially constant temperature without subjecting it at any time to an excessive temperature. This heating coil may be, and preferably is, externally heated, so that the oil as it circulates therethrough is slightly raised in temperature, preferably not more than 15 degrees above the temperature to be maintained in the body of oil in the evaporating chamber. We have found this differential in temperature ample to keep the body of oil in the evaporating chamber at a substantially constant temperature, this additional heat being sufficient to compensate for the loss of heat due to vaporization from the vaporizing chamber, loss due to radiation, etc. We have also found that by thus controlling the temperature of the oil being treated we need not pass the oil through a heating zone or coil heated to such degree as will tend to excessively crack any material part thereof or subject the oil at any time to an excessive decomposing temperature.

We have also discovered in the cracking of a relatively high boiling point oil to produce a relatively low boiling point fraction that where the oil to be treated is circulated from an evaporating chamber or bulk supply to and through a heating zone, chamber or coil the yield of low boiling point oil can

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be materially increased if the pressure on the heating coil or heating zone or chamber is maintained ten pounds or more in excess of the pressure kept upon the evaporating chamber or bulk supply. This increase in yield may be accounted for as follows: The oil passing through the heating coil is subjected to decomposing conditions of temperature and pressure and the lighter fractions being subjected to this higher temperature are superheated; a part of them are further decomposed or broken down, forming fixed gas and resultant high boiling point oils or residues, and are a loss. If an additional pressure is exerted upon the oil in the heating zone, chamber or coil, this action is materially prevented; that is to say, the light fractions are not further reduced due to the pressure increasing the density of the oil. We have found, therefore, that in a circulating system where the heating zone, chamber or coil is heated to a temperature five degrees or more in excess of the temperature maintained in the still proper or evaporating chamber such heated oil may readily be intermingled with the relatively cooler oil in the bulk supply or evaporating chamber; that such heated oil will give up a part of its heat to the oil in such still or evaporating chamber. Thereby the incoming or extra heated oil is cooled to a certain degree and this extra pressure can be released without the danger of such light or relatively low boiling point fractions breaking into gas. If, for example, the pressure upon the oil being treated in the evaporating chamber or bulk supply is sixty to one hundred pounds, then from ten to fifty pounds additional pressure may be maintained upon the oil as it is subjected to the temperature of the heating zone or coil. These pressures will vary somewhat with the decomposing or cracking operation being carried on and the character of oils being treated.

In ordinary cracking operations, where the temperature of the oil being treated and at the outlet of the heating zone, chamber or coil is materially higher than that the the oil in the bulk supply or evaporating chamber, the larger portion of the cracking is done in the heating zone, chamber or coil proper. This has a tendency to deposit an excessive amount of carbon in the heating chamber or element. We have found that by maintaining all the oil in the system at approximately the same temperature, or, in other words, maintaining a low differential temperature between the outlet from the heating element or chamber into the evaporating or bulk supply and the temperature of the oil in such evaporator or bulk supply that all or substantially all of the cracking or decomposition takes place in the evaporating chamber or bulk supply and not in the heating element or chamber. Thereby such carbon or high boiling point residues as are produced are liberated in the bulk supply or evaporator which form the storage portion of the system; from these such carbon or high boiling point residues may be readily discharged.

Preferably the oil to be treated is originally gradually brought up to the temperature of the desired cracking operation, thereby avoiding all sudden or excessive raises in temperature which produce excessive decomposition or cracking of portions of the oil.

While our invention is not dependent upon any particular form or construction of apparatus, it may be more fully and readily understood in connection with a system and apparatus by which it may be performed. We have, therefore, shown and illustrated in the accompanying drawings a diagrammatic view of a system or apparatus in which a preferred form of a process embodying our invention may be performed.

We prefer to originally bring the entire body of the oil, to be subjected to the cracking operation, to the required cracking temperature without subjecting any portion thereof to an abrupt or to an excessive raise in temperature, thereby avoiding excessive cracking and to subject all the oil to an even and uniform cracking distillation. To this end we prefer to provide for a primary or preparatory heating of the charging stock before it is introduced into the cracking unit or system. Such primary or preparatory heating of the charging stock, however, forms the subject matter of our application filed August 29, 1921, Serial No. 496,403.

In the drawing, 1 indicates a storage vessel for the high boiling point oil which is to be cracked; 2 a suitable pump designed to pump such oil from the storage 1 and force the same through a pipe or conduit 3. 12 indicates a storage vessel for the solvent oil which is to be mixed with the high boiling point oil to be cracked, for the purpose of taking into solution the heavy bodies produced by cracking such high boiling point oil and preventing such heavy bodies from being so reduced as to cause deposition in the system. Such "solvent" oil may be any lower boiling point fraction of the same oil, of which the oil to be cracked is a part, or of any other oil provided, however, that such "solvent" oil shall be substantially unaffected at the pressure and temperature employed in the cracking of the particular oil operated upon. It is also understood that the preferred embodiment of our process is not limited to the use of any particular non-crackable or "solvent" oil either produced in the system or added from any suitable source but may be merely a relatively low boiling point fraction of the oil, cracking of the high boiling point fraction whereof is

to be performed. The use of such a solvent oil is incident, however, only to the preferred form and embodiment of our process. 13 indicates a pump adapted to draw solvent oil through the pipe 14 from the vessel 12 and force it through a pipe or conduit 15 into the pipe or conduit 3 where it is mixed with the oil to be cracked. It is obvious that mixing of the oil to be cracked and solvent oil may take place before the same are supplied to the storage or supply tanks or vessels of the system in which case such mixture may be drawn directly from one tank or vessel and forced through a pipe or conduit 3. From the pipe or conduit 3 this charging stock is forced into and through a waste heat exchanger 4 at the condenser 18 and thence through a continuation of such pipe or conduit 3 through a heat exchanger 5, where such charging stock is subjected to the waste heat of the reflux condenser. From such heat exchanger 5 the conduit 3 is preferably carried to a waste heat exchanger 6 at the discharge or withdrawal of the hot residual solution of the system. From this heat exchanger 6 the charging stock is forced through a continuation of the conduit 3 into and through a heating chamber or zone 7. This heating zone or chamber is indicated in the form of a coil 7 and may be of the ordinary or preferred construction and fired or heated in any preferred manner. By means of this coil the charging stock is brought to the desired temperature for introduction into the cracking system. Such desired temperature is necessarily higher than any temperature to which the charging stock could be raised by mere waste heat of vapor heat exchangers. From the heating unit or coil 7 a pipe or conduit 8 leads into the heating coil or chamber or zone 16 of the cracking system. While we prefer to introduce the primarily or preparatorily heated charging stock directly into such heating coil, it may be introduced at any other desired point in the system.

The cracking apparatus or system proper is indicated as consisting of a suitable vaporizing chamber or evaporator 9. 10 represents a pump connecting on its suction side by means of a pipe 11 with the vaporizing chamber or evaporator 9 and on its discharge side with a pipe 25 leading to the heating element or coil 16 of the cracking system. This heating coil or element 16 is preferably mounted in a suitable furnace 26 where it is either directly or indirectly heated as preferred. The heating coil or element 16 is connected by means of a pipe or conduit 27 with the vaporizing chamber or evaporator 9. 27' indicates a suitable valve by means of which a differential pressure may be maintained on the oil in the vaporizing chamber 9 and heating chamber or coil 16. 28 represents the vapor line from the evaporator 9. 17 represents a dephlegmator or reflux condensing apparatus in said line 28 and 18 is a condenser connected with said dephlegmator. 19 indicates a receiver connected with the condenser and 20 is a valve where pressure is released and the condensate delivered to storage. 21 is a discharge pipe from the evaporator 9. 22 is a cooler to which the pipe 21 leads through the waste heat exchanger 6. 23 is a discharge valve from the cooler and 24 is a receiver. The pump 2 affords a means by which any desired pressure may be placed and maintained upon the charging stock as it is being primarily heated.

The presence in the charging stock of a fraction of oil of lower boiling point than the oil to be cracked which lower boiling point fraction is substantially unaffected at the temperature and pressure of the cracking operation, provides a medium by which the high boiling point derivatives and heavier bodies produced from the cracking of the oil may be carried in solution and be prevented from being reduced so heavy or so near to tar or carbon as to deposit in the system. In other words, this solvent oil immediately takes and holds in solution the relatively higher boiling point oil or fraction produced by the cracking, so that it may be discharged from the apparatus. Upon the cracking of the crackable oil into such relatively high and low boiling point fractions, this solvent oil immediately takes into solution and holds such relatively high boiling point derivatives from further reduction to tar or carbon. If this solvent oil solution is permitted to become overcharged, deposition in the system takes place as these higher boiling point derivatives or fractions, heavy hydrocarbons, tarry or carbonaceous bodies take the brunt of the heat, and unless held in solution by the solvent oil become further reduced towards tar or carbon. The degree of concentration, (of the solvent oil and high boiling point derivatives produced by the cracking of the crackable oil,) which may be permitted in the system without danger of deposition will, of course, depend upon the oils charged into the system, as, for example, the carbon residue test should not exceed ten times that of the charged oils. This is merely an example and will vary with the oils.

In the cracking of certain petroleum distillates there may be produced from the operation sufficient solvent or non-crackable oil of unsaturated form to keep the higher boiling point derivatives or solid hydrocarbons, tarry residues, etc., in solution, so that no deposit will form on the metal surface of the heated element, in which case it is unnecessary to add solvent or non-crackable oil from an outside source. A certain amount of non-crackable or solvent oil passes off

with the higher boiling point derivatives in solution. This may be replaced from storage as needed.

As an example of the proportion of oil to be charged with a solvent oil, we add one volume of the former to as much as three or five volumes of the latter in the system at any one moment; and as an example of a desirable cracking pressure and temperature of the oil to be cracked, we give one hundred to one hundred twenty pounds absolute and seven hundred forty-five degrees to eight hundred degrees F. in the evaporating chamber, but it is understood that these proportions and the pressure and temperature may vary according to the oils used and the cracking operation or reaction sought.

While this preferred embodiment of our invention includes this primary or preparatory heating of the fresh charging-stock and the use of a solvent oil, the invention is not necessarily limited thereto as either our discovery of the advantageous use of an excess pressure of from ten to fifty pounds over the pressure maintained in the vaporizing chamber, reflux apparatus and condenser, or the temperature control wherein the temperature of the oil being treated as it is present in any two parts or portions of the system does not differ more than approximately fifteen degree F., or the rapid "turnover" or subjecting of all the mass or body of oil in the system to the heating chamber or coil at least once in each approximately ten minute period of the operation may be utilized separately. Each of these discoveries we, therefore, claim separately and independently, although we prefer to combine all of them in a single process and thereby secure the maximum efficiency, economy and yields.

Where we do not add more than approximately fifteen degrees F. upon the passage of the oil through the heating zone or coil, we have found it very advantageous to submit the oil on an average of not less than twenty times to such heating zone, depending upon the oil being treated, and sometimes as high as one hundred times before discharge from the system. By thus subjecting the oil to repeated moderate additions of heat to maintain a given substantially constant temperature, we minimize the possibility of excessive cracking or decomposition and produce the maximum amount of the desired product with a minimum formation of high gravity derivatives, the minimum loss by production of fixed gas and produce in the low boiling point product the minimum unsaturated bodies. If the "turnover" or subjection of the entire body of oil in the system to the heating zone is not thus maintained, portions of the cracking system must be heated to higher temperatures in order to produce and maintain the decomposing or cracking reaction.

It is obvious that the temperature of the oil in the heating coil or other heating zone must be relatively higher than the temperature of the oil in the vaporizing chamber or other portions of the system. If, therefore, the temperature of the oil in the coil be allowed to rise materially beyond that of the bulk oil in the vaporizing chamber, it is evident that vaporization will occur in the coil unless provision is made to prevent this. This, vaporization may be prevented by maintaining a certain predetermined pressure on the oil in the heating coil or heating zone in excess of that of the balance of the system, (i. e., vaporizing chamber, condenser, etc.). This differential pressure may be maintained by means of the valve 27 indicated in the drawings or in several other ways, and we do not limit ourselves to any particular means therefor, as, for example, a restricted outlet from the coil to the vaporizer may be used, or by maintaining a sufficiently rapid flow through the heating coil to cause an appreciable back pressure (velocity head). The latter is preferable, as it insures a sufficiently rapid flow of oil through the heating coil to prevent accumulation of high boiling point derivatives, carbon, etc., in addition to preventing any appreciable vaporization in the heating coil itself.

We claim:

1. In a cyclic process of cracking petroleum oil under a substantially constant cracking temperature and pressure both of which are substantially uniform throughout the cracking system, which includes a heating zone and an evaporating chamber, that step which includes maintaining the entire body of oil in the system under the conditions of temperature and pressure of the cracking reaction and substantially confining the cracking reaction to the evaporating chamber, by forcibly circulating the oil from the evaporating chamber to and through the heating zone and back to the evaporating chamber at such a relation of speed and volume of circulation as to maintain such circulation equal to passing such entire body of oil through the heating zone at intervals of not substantially more than ten minutes whereby such constant temperature and pressure is maintained throughout the system.

2. In a cyclic process of cracking petroleum oil under pressure in a closed system wherein a relatively large body of oil is maintained in the evaporating chamber of the system and a relatively small stream thereof is circulated to and through a heating zone and back into said chamber, to produce a substantially uniform cracking reaction in said chamber during the entire run,

that step which consists in maintaining, during the entire run, all portions of such oil at so nearly the same temperature that the temperature of the oil at its exit from the heating zone is less than 15° F. above the temperature of the oil in said chamber.

3. In a cyclic process of cracking petroleum oil under a substantially constant cracking temperature and pressure both of which are substantially uniform throughout the cracking system, which includes a heating zone and an evaporating chamber, maintaining the entire body of oil in the system under the conditions of temperature and pressure of the cracking reaction, maintaining upon the oil in the heating zone a pressure of not less than ten pounds in excess of the pressure upon the oil in the evaporating chamber, and substantially confining the cracking reaction to the evaporating chamber, by forcibly circulating the oil from the evaporating chamber to and through the heating zone and back to the evaporating chamber at such a relation of speed and volume of circulation as to maintain such circulation equal to passing such entire body of oil through the heating zone at intervals of not substantially more than ten minutes whereby such constant temperature and pressure is maintained throughout the system.

4. In a cyclic process of cracking petroleum oil in a closed circulating system under a substantially constant cracking temperature and pressure, both of which are substantially uniform throughout the cracking system, including a heating zone and an evaporating chamber, maintaining a relatively large body of oil in the evaporating chamber and circulating a relatively small stream thereof to and through the heating zone and back into said chamber, to produce a substantially uniform cracking reaction in said chamber during the entire run and to substantially confine the cracking reaction to the evaporating chamber, by forcibly circulating the oil from the evaporating chamber to and through the heating zone and back to the evaporating chamber at such a relation of speed and volume of circulation as to maintain such circulation equal to passing such entire body of oil through the heating zone at intervals of not substantially more than ten minutes, and maintaining, during the entire run, all portions of such oil at so nearly the same temperature that the temperature of the oil at its exit from the heating zone is less than 15° F. above the temperature of the oil in said chamber, whereby such constant temperature and pressure is maintained throughout the system.

5. A continuous cyclic cracking process, consisting in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating the oil is brought approximately to the active cracking reaction temperature of the higher boiling point fractions of the oil, a material portion of the heat necessary to raise the oil to such temperature being supplied by heating means independent of the heating means of the cracking system proper, then passing such heated liquid into a circulatory cracking system proper, which includes a heating zone and evaporating chamber, in which chamber a relatively large body of oil is maintained, maintaining such oil at a substantially constant cracking temperature and pressure substantially uniform throughout the circulating system of said heating zone and chamber during the entire run by forcibly circulating a relatively small stream thereof from the evaporating chamber to and through the heating zone at such a relation of speed and volume of circulation as to maintain such circulation equal to passing the entire body of oil through the heating zone at intervals of not more than ten minutes, and maintaining, during the entire run, all portions of such oil at so nearly the same temperature that the temperature of the oil at its exit from the heating zone is less than 15° F. above the temperature of the oil in said chamber whereby the cracking reaction is substantially confined to said chamber.

6. A continuous cyclic cracking process, consisting in primarily heating a moving body of petroleum oil having a material range of boiling points to a temperature above the boiling point of a fraction or fractions thereof while subjecting the same to a pressure sufficient to maintain the same in substantially liquid form, in which primary heating the oil is brought approximately to the active cracking reaction temperature of the higher boiling point fractions of the oil, a material portion of the heat necessary to raise the oil to such temperature being supplied by heating means independent of the heating means of the cracking system proper, then passing such heated liquid into a cyclic cracking system proper, including a heating zone and an evaporating chamber wherein the entire body of oil in such system is maintained under substantially constant conditions of cracking temperature and pressure and the cracking thereof substantially confined to the evaporating chamber, by forcibly circulating the oil from the evaporating chamber at such a relation of speed and volume of circulation as to maintain such circulation equal to passing such entire body of oil through the heating zone at intervals of not substantially more than ten minutes whereby such constant tempera-

ture and pressure is maintained throughout the system without subjecting any portion of the oil to excessive local temperature so that resultant excessive cracking and carbon deposit in any portion of the heating zone is avoided.

7. The cyclic process of cracking petroleum oil which consists in primarily heating the oil to approximately the temperature of the cracking reaction, continuously feeding the primarily heated oil into a closed cyclic cracking system proper, including a heating zone and an evaporating chamber, maintained at a substantially constant cracking temperature and pressure both of which are substantially uniform throughout the cracking system, maintaining a relatively large body of oil in the evaporating chamber and forcibly circulating a relatively small stream thereof therefrom through the heating zone and back into the chamber at such a relation of speed and volume of circulation as to maintain such circulation equal to passing such entire body through the heating zone at intervals of not substantially more than ten minutes whereby said constant temperature and pressure are maintained, continuously withdrawing the low boiling point vapor as produced and continuously discharging from the system high boiling points products of such cracking, whereby a substantially constant volume is maintained in the system.

Signed at Richmond, California, this 12th day of September, 1921.

RICHARD W. HANNA.
WILLIAM D. MASON.
WALTER G. HAMILTON.

Witnesses:
FREDERICK S. LYON,
CHESTER E. SINGER.

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July 17, 1923. 1,462,143

F. T. MANLEY

METHOD OF CRACKING HYDROCARBON OILS

Filed Oct. 10, 1917

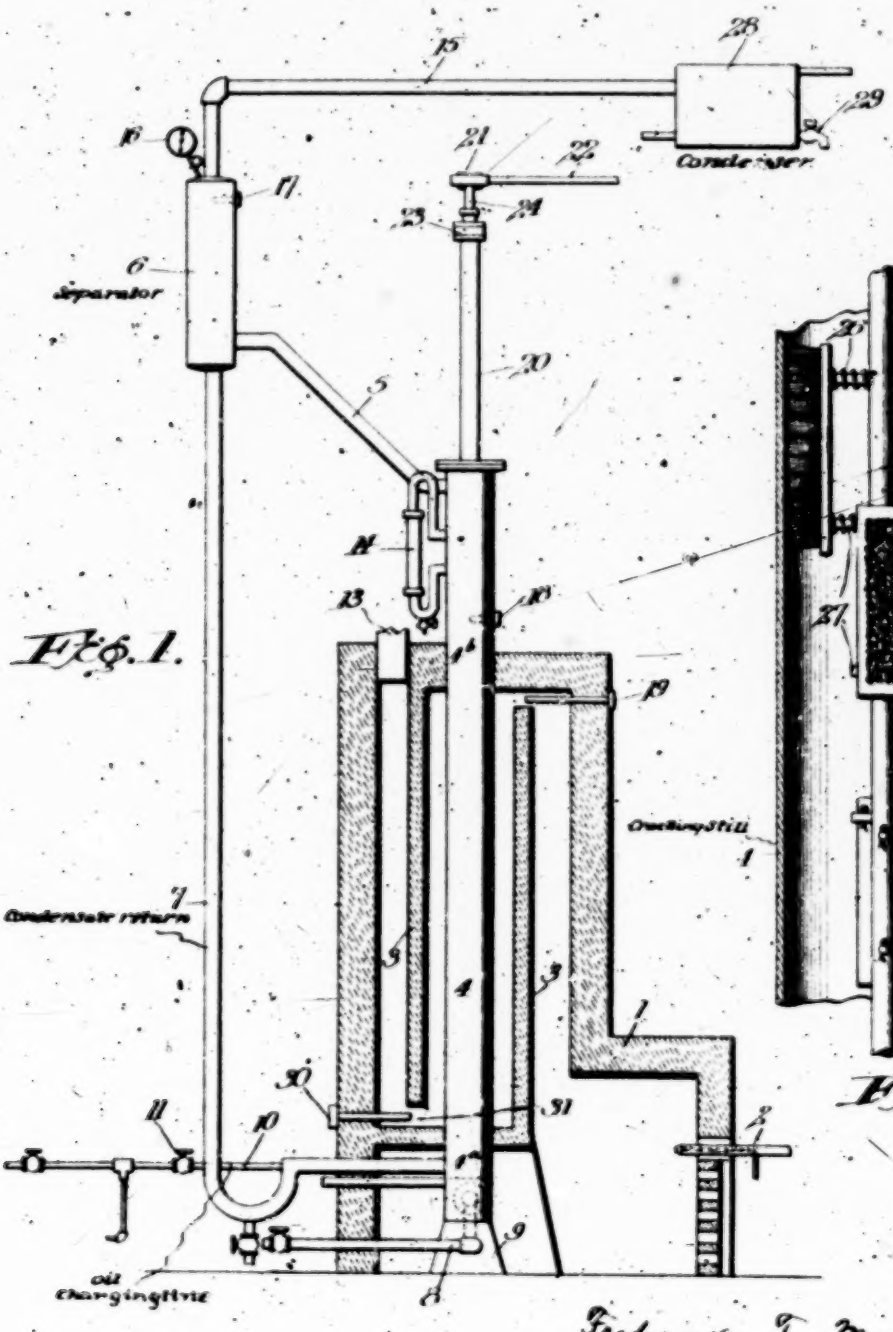

Fig. 1.

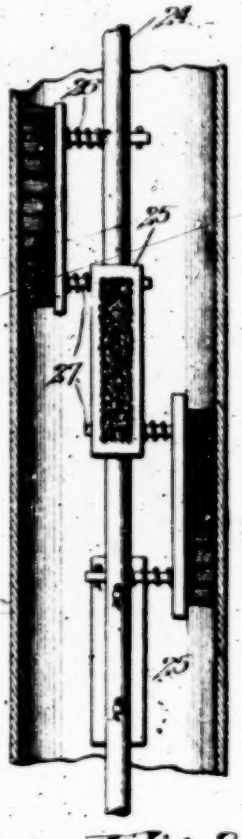

Fig. 2.

Inventor

Frederick T. Manley

By Foster, Freeman, Watson & Coit

Attorneys

Patented July 17, 1923.

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1,462,143

UNITED STATES PATENT OFFICE.

FREDERICK T. MANLEY, OF HOUSTON, TEXAS, ASSIGNOR TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF TEXAS.

METHOD OF CRACKING HYDROCARBON OILS.

Application filed October 10, 1917. Serial No. 195,775.

To all whom it may concern:

Be it known that I, FREDERICK T. MANLEY, a citizen of the United States, residing in Houston, Harris County, and State of Texas, have invented certain new and useful Improvements in Methods of Cracking Hydrocarbon Oils, of which the following is a specification.

This invention relates to novel processes by which higher-boiling hydrocarbons are decomposed or broken up into lower-boiling hydrocarbons. It relates particularly to the cracking of such oils as kerosene, gas oil, lubricating oil, and the like, for the production of more volatile products, such as are usually designated by such terms as gasoline and naphtha. More especially it relates to novel and improved processes by which is effected the decomposition of certain of the more readily volatilized constituents which are formed in cracking the higher-boiling hydrocarbons, and which, although not sufficiently volatile for gasoline or naphtha are yet so readily volatilized that it is difficult under existing practices to hold them within a zone of sufficient heat to decompose them.

In the practice of cracking hydrocarbons for the production of the more volatile products, as gasoline, considerable difficulty has hitherto been experienced in the proper disposal of the large proportion of constituents of the kerosene type usually formed when using the requisite pressures and temperatures needed for cracking the hydrocarbons which it is commonly sought to decompose into gasoline. Attempts have been made to effect a cracking of these constituents by returning them to the still by such methods as the use of inclined vapor lines and traps of various kinds, but the volatility of said constituents is such that upon coming in contact with the vapor portion of the still they are vaporized by the heat without, however, being heated sufficiently for decomposition. The result is that these constituents of the kerosene type tend to collect in great quantities in the upper portions of the still and in the vapor lines leading therefrom. They are too heavy to be used for the gasoline fractions, yet are so easily volatilized that they do not drop back into a zone of sufficient heat to decompose them into lighter products. As a result of the accumulation of these kerosene constituents the operator is forced to increase the pressures used, thus augmenting the danger, as well as the expense of carrying on the operation. It is an object of this invention to collect these constituents of the kerosene type, return them directly to the bottom of the still into which they are positively forced and retain them there for a sufficient time to decompose them into more volatile products.

Certain novel apparatus for carrying out the herein disclosed process is illustrated in the accompany drawing, but is not claimed herein as it is made the subject of my copending application Serial No. 195,774, filed October 10, 1917.

In the drawings,

Figure 1 shows partly in vertical section an apparatus adapted to carry out my invention; and

Figure 2 is an enlarged section of a portion of the cracking tube showing scraping means therein.

Referring to the drawing, a cracking still 4, with suitable supports 9 heated intermediate its ends, is placed in a furnace 1, having baffle walls 3, burner 2 and stack 13. A vapor line 5 extends from the upper portion of the cracking still above the heating zone to an air condenser 6. A return conduit 7 reaches from the air condenser directly to the lower portion of the cracking still 4 below the heating zone in order to return condensed material. 8 is a valved draw-off pipe at the bottom of the cracking still 4.

The still is preferably equipped with a supply pipe 10 entering the horizontal section of the conduit 7 whereby the introduction of the oil charge is caused to produce an injector effect by which the material in the pipe 7 may be forced into the still.

A vapor line 15 extends from the air condenser 6 to suitable water condensers 28. The outlet from the condenser 28 has a valve 29. 16 denotes a pressure gauge on the air condenser to indicate the vapor pressure therein. 17 and 18 designate recording thermometers on the air condenser and cracking still, respectively, and 19 and 30 furnace pyrometers. A gauge 14 for indicating the liquid level in the still 4 is situated at the upper part thereof.

In this form of apparatus the oil in the cracking still 4 forms an extended vertical

column and the charging oil and condensate forcibly supplied at the bottom, passes up through that column and is thus subjected to the cracking operation. In order to keep the inner surface of the cracking still clean and prevent the collection of material on that surface, I preferably provide a scraping device as shown in detail in Figure 2. The scraping device includes a shaft 24 extending centrally down into the cracking still and engaging any suitable bearing at the bottom. This shaft carries steel brushes 25, the brushes being secured to the shaft by the rods 27, around which are placed coiled springs 26 to yieldingly press the brushes against the inner surface of the still 4. The shaft 24 may be driven through a worm gear 21 from the shaft 22. In order to support the shaft at its upper end I preferably mount a pipe 20 in the upper end of the still 4 slightly larger in diameter than the shaft 24, and at the upper end of this pipe 20 I place a stuffing box 23. The purpose of this pipe 20 is to place the stuffing box in a relatively cool position. The brushes in the still 4 are placed only in the cracking zone which, as illustrated in Figure 1, is between the parts marked 4^a and 4^b.

The heating arrangements of the furnace are such that the hot combustion gases pass upward from the burner 2 between the furnace wall 1 and baffle 3 until they are deflected by the top wall of the furnace into the heating chamber which contains the cracking still and is formed by the baffle 3. The hot gases pass downwardly imparting heat to the cracking still and find exit at 31 to and through the stack 13. The upper and lower ends of the cracking still preferably extend beyond the heating zone.

In the operation of my process, I charge the still 4 with the hydrocarbon oil which it is desired to decompose into lighter products, such as gasoline. The liquid level throughout the operation is maintained at a point above the heating zone in the upper portion of the still. By regulating the supply of oil entering the still through the charging line 10, hydrocarbon in the cracking still is ordinarily heated to from 650° to 800° F., the exact temperature needed being dependent upon the character of the charge. I maintain and regulate pressure in the apparatus by means of the valve 29, in the condenser outlet. I use a pressure not ordinarily below 100 lbs. and may employ one as high as 300 lbs. The vapors generated pass out from the cracking still through the vapor line 5 to the air condenser 6. The constitutents of the desired volatility, that is, ordinarily those of the gasoline or naphtha type, are carried to the water condensers by the conduit 15.

The less volatile constituents, that is, ordinarily predominantly those of the kerosene type are liquefied in the air condenser and dropped down into the return conduit 7 by which said constituents are carried back directly to the cracking still.

The returned condensate is forced in at the bottom of the heated liquid column in the cracking still and by reason of the fact that its boiling point is below the mean boiling point of the contents of the still it tends to vaporize comparatively rapidly thereby creating a current up through the liquid column. This current acts as a carrier of the light hydrocarbons being generated in the cracking operation and serves to remove them from the cracking zone as formed, thus preventing decomposition of the light liquefiable hydrocarbons into permanent gases.

By reason of the extent of the cracking zone the returned condensate is subjected to a cracking temperature for a sufficient time to cause the conversion of substantial portions thereof into the desired volatile products. The operation is cyclic, the heavier condensates collecting in the separator 6 continuously being returned to the cracking still 4 and passed upward through the heated liquid column, thus continuously decomposing these returning constituents into lighter and more volatile products. In this manner the constituents of the kerosene type, which have hitherto been found so difficult to crack, may readily be decomposed into the desired products. By carrying on the cracking in the liquid phase the conversion is effected without heating the hydrocarbons unduly or unevenly thus avoiding undue carbonization and the formation of excessive quantities of gas or of unsaturated compounds.

By continuously returning to the cracking still 4 the condensate collected in the separator 6 the zone of reaction in the cracking still 4 is saturated with hydrocarbons of the kerosene type thus bringing about a chemical equilibrium tending to a reduction in the formation of this type of hyrocarbons and making possible an increased formation of the gasolene products desired.

The tube 7 is insulated so as to prevent undue loss in heat by the products passing through it. By returning these constituents to the heating zone while still in a heated condition a considerable economy is effected in the amount of fuel required to carry on the cracking operation.

The volatile product desired leaves the separator 6 in the form of vapor and is conducted by the vapor line 15 to the condenser 28 wherein the product is condensed, the condensate being withdrawn through the valved outlet 29. The residue collecting in the still may be drawn off as desired through the outlet pipe 8.

It is well known that the character of the products returned to the cracking still from the air condenser by means of the conduit 7

will vary not only with the character of the hydrocarbon oil introduced into the still, but with the temperature and pressures employed, and with other variable factors, as the speed of the operation, so that in the normal operation of the process certain constituents may be returned which may not come strictly within the meaning of the term "kerosene" as that word is commonly employed in the art. But I prefer to use the word "kerosene" herein, since in the normal operation of the process the returned constituents are predominantly those of the kerosene type. It is understood that by means of my process the products generated by the cracking operation, which are less volatile than desired, and which either through the readiness with which they are vaporized, or on account of mechanical action or other cause, pass out from the cracking zone, are continuously and directly returned to the cracking zone and are forced through the heated liquid column so that these constitutents are all eventually decomposed into products of the gasoline or naphtha type.

What I claim and desire to secure by Letters Patent is:

1. The continuous method of cracking hydrocarbon oils which comprises charging the oil into an elongated vertical still to maintain therein an extended column of liquid oil, maintaining said column of oil under temperature and pressure sufficient for cracking, collecting the generated vapors and separating therefrom the less volatile constituents thereof, continuously and directly returning said less volatile constituents and positively forcing them into the bottom of the still so that they are caused to pass through substantially the full length of the extended column of oil therein, and condensing the constituents of desired volatility.

2. The continuous method of cracking hydrocarbon oils which comprises charging the oil into an elongated vertical still to maintain therein an extended column of liquid oil, maintaining said column of oil at a temperature and pressure sufficient for cracking, removing residue and vapors from the still to maintain a substantially constant liquid level therein, separating out the heavier constituents of said vapors and directly returning said constituents in cyclic passage through substantially the full length of the extended column of oil by positively forcing them into the bottom of the still.

3. The continuous method of cracking hydrocarbon oils that comprises charging the oil into the bottom of an elongated vertical still to maintain an extended column of liquid oil therein, maintaining said column of oil under sufficient heat and pressure for cracking, separating out the heavier constituents of the evolved vapors, and directly returning and injecting them with the charging oil into the bottom of the still so that they are caused to pass through substantially the full length of the extended column of oil therein.

4. The continuous method of cracking hydrocarbon oils that comprises charging the oil into a vertical still to maintain therein an extended column of liquid oil, heating said column of oil intermediate the ends of the still to maintain a cracking temperature therein, allowing the generated vapors to collect in the upper end of the still above the portion thereof to which heat is applied, continuously removing the collected carbon formed and causing it to collect at the bottom of the still below the heating zone, controlling the removal of the vapors from the still to maintain therein a superatmospheric pressure, separating out the heavier constituents of the vapors and directly returning said constituents in cyclic passage through substantially the full length of said column of oil by forcing them together with the charging oil into the bottom of the still.

5. The continuous method of cracking hydrocarbon oils which comprises charging the oil into an elongated vertical still to maintain therein an extended column of liquid oil, maintaining said column of oil under temperature and pressure sufficient for cracking, collecting the generated vapors, cooling said vapors to condense the heavier constituents thereof, preventing further cooling of the resulting condensate and directly returning same in a heated condition and positively forcing it together with the charging oil into the bottom of the still so that the condensate is caused to pass through substantially the full length of the extended column of oil therein.

6. The continuous method of cracking hydrocarbon oils which comprises charging a stream of oil into the bottom of a cracking still to maintain a body of oil therein, maintaining the oil therein under pressure and at a cracking temperature, removing the evolved vapors, separating out the heavier constituents thereof, and returning them directly to the still for further treatment by positively forcing them in the stream of charging oil into the bottom of the still.

7. The continuous method of cracking hydrocarbon oils which comprises charging the oil into an elongated vertical still to maintain an extended column of liquid oil therein, maintaining said column of oil under temperature and pressure sufficient for cracking, collecting the generated vapors, separating therefrom the less volatile constituents, and positively forcing them into the bottom of the still so that they are caused to pass through substantially the full length of the extended column of oil therein.

8. The continuous method of cracking hydrocarbon oils which comprises charging the oil into a still to maintain a body of oil therein, subjecting the oil therein to cracking temperature and pressure, removing the evolved vapors, separating out the heavier constituents thereof, and returning them in heated condition in cyclic passage to the still for further treatment by positively forcing them into the bottom of the still.

In testimony whereof I do affix my signature.

FREDERICK T. MANLEY.

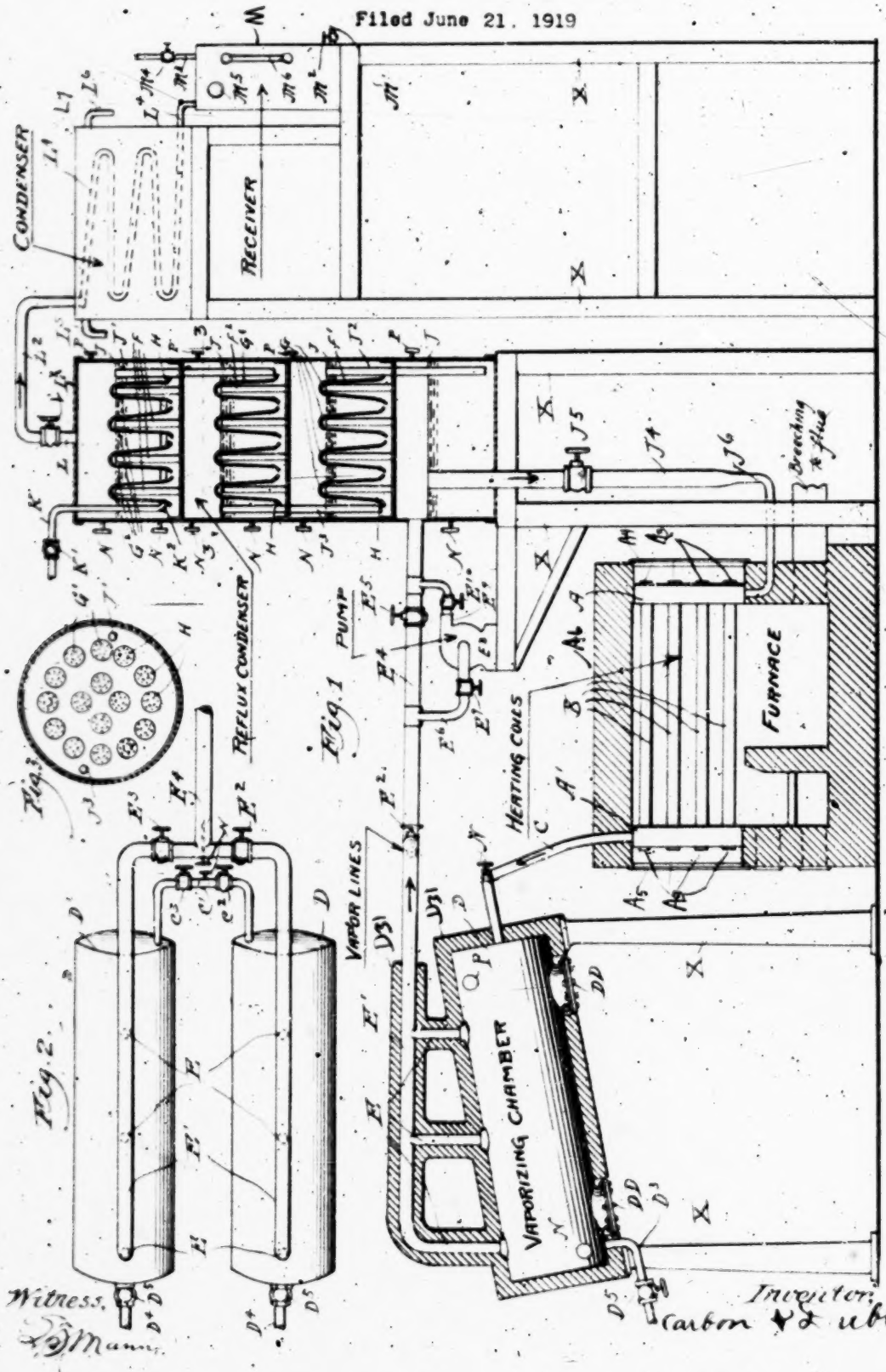
3416

March 25, 1924. 1,488,325

C. P. DUBBS

PROCESS FOR TREATING PETROLEUM

Filed June 21, 1919



Patented Mar. 25, 1924.

3417
1,488,325

UNITED STATES PATENT OFFICE.

CARBON P. DUBBS, OF WILMETTE, ILLINOIS, ASSIGNOR TO UNIVERSAL OIL PRODUCTS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF SOUTH DAKOTA.

PROCESS FOR TREATING PETROLEUM.

Application filed June 21, 1919. Serial No. 305,793.

To all whom it may concern:

Be it known that I, CARBON P. DUBBS, a citizen of the United States, residing in Wilmette, county of Cook, and State of Illinois, have invented certain new and useful Improvements in Processes for Treating Petroleum, of which the following is a specification.

This invention relates to a process for treating petroleum and other hydrocarbons to produce products therefrom, having lower boiling points.

The invention contemplates a process for continuously treating petroleum; a process whereby petroleum is passed through a heating zone, thence through a vaporizing or converting chamber wherein vaporous products are released and the heavier residual material is drawn off; a process in which the vapors liberated in the vaporizing zone are passed through a series of pools of liquid oil subjecting the vapors to a dephlegmating action; a process in which the circulation of the vapors may be controlled by a pump interposed in the vapor line; a process which utilizes the raw oil as a reflux condensing agent, the condensate combining with the raw oil prior to its being introduced to the heating zone; a process whereby an increased amount of the heat generated is utilized in the system; a process in which the raw oil is caused to circulate down through successive pools maintained in the dephlegmator, subjecting the vapors bubbling therethrough to a refluxing action, the raw oil and condensate being drawn off from the bottom of the dephlegmator; a process whereby the oil under treatment is heated in one stage and such heat treatment so controlled and regulated as to prevent any substantial deposition of carbon in such zone; a process in which the oil to be treated is fed continuously or intermittently by passing it through succeeeding pools of oil before being passed to the cracking tubes, such oil being freed of that portion having the desired low boiling points while dephlegmating the vapors in said pools.

The invention and apparatus reside in such features of construction and such process and method features as will more fully be hereinafter described.

In the drawings:

Fig. 1 is a diagrammatic side elevation in section of an apparatus, by which my process can be carried out.

Fig. 2 is a top plan view of the yaporizing chambers and the immediate piping.

Fig. 3 is a top cross sectional view of that section of Fig. 1, in which the pools of oil are shown. This is a cross section taken on the line 3—3 of Fig. 1.

In describing the attached drawing, and operation of the process, the oil to be treated is drawn from a source (not shown), and is forced into the apparatus through valve marked K^1, through line K, through the line K^2, which section is perforated that extends across the bottom of the top pool of oil in the chamber marked L^x. The portion vaporizing as said oil percolates up through this pool of oil is passed off through vapor line L, through the pressure regulating valve L^1, through gooseneck L^2, through condensing coil L^4 positioned in condensing tank L^7, through line L^6 into tank M, along with the incondensable gases. Water is fed to tank L^7 through line L^5 and travels out of said tank through line L^6. The condensate collected in tank M is drawn off through line M^1 having positioned thereon pressure regulating valve M^2, while the incondensable gas is drawn off through line M^3 through pressure regulating valve M^4 and on this tank is a liquid level gauge M^6 and a pressure gauge M^5. Tanks M and L^7 rest on the supports marked X.

The level of the top pool of oil in the chamber L^x is maintained at approximately J and any surplus flows through pipe J^1 into the pool of oil directly thereunder, the level of this pool being maintained at point marked J. Any excess travels through line J^3 into the bottom of the pool of oil immediately thereunder, the level of this pool being maintained at point J and any excess travelling through the line J^2 into the pool of oil immediately thereunder and this pool is maintained at a level marked J and any excess travels through line J^4, having posi-

tioned on its valve J^5. At the bottom of line J^4, the cross sectional area is reduced as shown at J^6, the larger sized pipe used in J^4 being for the purpose of allowing the oil to be, more or less, freed of any vapors contained therein, such vapors passing back up through said pipe into the bottom of the chamber L^x. The remaining liquid passes through line J^6 into header A, and passes through lines B into header A^1. In each of these headers opposite each end of the tubes B are positioned plugs A^3, for the purpose of allowing entry to said tubes for cleaning same and opposite these plugs are furnace doors A^4 and A^5, which by opening give ready access to said plugs.

The tubes B and headers A and A^1 are positioned in the furnace A^6. As the oil passes through these tubes B from header A to header A^1, it is subjected to heat, which converts a portion into lower boiling point products, and the oil flows from header A^1 through line C, into header C^1. having positioned therein pyrometer N and though valve C^2 into retort D, which retort has manholes marked D—D, pressure gauge P and pyrometer N.

As the oil passes through tank D, a proportion of same is vaporized and passes up through vapor lines E into header E^1, through valve E^2 into line E^4, which also has a pyrometer marked N. Through the line E^4, the valve E^5 being opened while the valves E^7 and E^{10} are closed, the vapors pass into the bottom compartment of the chamber L^x. Any proportion condensing drains into the bottom compartment of chamber L^x, and is automatically returned to the heating tubes B through line J^4. The uncondensed portions pass up through the pipes marked F^1 and by means of caps G are forced down and discharged near the bottom into the pool of oil in that chamber. The bottoms of the caps marked G are perforated at the points marked H. The vapors as they bubble up this pool of oil give up more or less of their heat and more or less of same are condensed and as they bubble up through this liquid, they are more or less scrubbed. The excess oil accumulated in this pool travels through pipe J^2 into the pool of oil contained in the compartment directly thereunder, the pipe J^2 extending down into the pool of oil to a point near the bottom, thus forming a liquid seal so that no vapors contained in the lower chamber can pass up through pipe J^2 into the upper chamber. The remaining vapors pass up through pipes F^2 and are forced by means of caps G^1 down to near the bottom of the pool of oil contained in this chamber and there escape into said pool of oil through the perforations at a point marked H in said caps or if these are not of sufficient capacity, the excess vapors can pass clear down under the bottom of the caps and escape up through the oil from that point.

As such vapors percolate up through this pool of oil, more or less of the heat in same is extracted and acquired by the pool of oil, thus causing more or less of the vapors to condense and be retained in such pool of oil and act to have a scrubbing effect on remaining vapors. The surplus oil accumulating in this chamber travels through pipe J^3 into the pool contained in the chamber immediately thereunder, such pipe extending to near the bottom of said latter pool, so as to prevent any vapors passing therethrough from the latter chamber up into the former chamber. The remaining vapors in the last mentioned pool pass up through pipes F and by means of caps G^2 are forced down to near the bottom of the pool of oil contained in this chamber and are there discharged into said pool of oil through the perforated places marked H or by passing completely under the bottom of caps G^2 and as they percolate up through this pool of oil, more or less heat is extracted therefrom and retained in the oil forming this pool, which causes more or less of such vapors to be condensed and retained in this pool of oil and the surplus of such oil overflows through pipe J^1 into the pool immediately thereunder, being discharged in said pool near the bottom so as to prevent any vapors in said lower chamber passing through this pipe into the upper chamber. There may be as many pools of oil as are shown in the chamber L^x or as desired or found necessary to sufficiently scrub the vapors passed therethrough and to reduce and condense any desired portions of the vapors to produce the desired boiling point, the remaining vapors passing from said chamber L^x through pressure regulating valve L^1, through gooseneck L^2 as already described. These pools of oil may be contained in one chamber as shown in the drawing and marked L^x or in more than one chamber. The excess oil in the bottom pool of each chamber being returned to the heating pipes B in the same manner as shown in the drawing, and as this will be readily understood by those versed in the art, I have not deemed it necessary to show more than one chamber marked L^x.

In case it is desired to stimulate the flow of vapors from the vaporizing chamber into and through the chamber L^x, a pump is provided marked E^8 and connected to the vapor line E^4 by means of line E^6, having positioned on it valve E^7 and on the discharge side of the pump it is connected to vapor line E^4 by line E^9, having positioned on it valve E^{10} and to use this pump for pumping, the valve E^5 would be closed on line E^4 and valves E^7 and E^{10}

would be open, and pump put in operation, thereby causing the vapors to travel from line E^4 through line E^6, through pump E^8, through E^9, back through line E^4 on the opposite side of the valve E^5 from which the vapors were originally drawn from line E^4.

In different parts of this vaporizing chamber are shown pyrometers marked N and pressure gauges marked P. The chamber L^7 and pump E^8 are positioned on supports marked X. The portion of oil in the vaporizing chamber D remaining unvaporized is drawn off either continuously or intermittently through line D^3, through valve D^5 and with it is carried off more or less of the carbon formed in the cracking of the oil. Vaporizing chamber D is duplicated as shown in vaporizing chamber marked D^1. This is for the reason that when it becomes necessary to clean vapor chamber D, the rest of the apparatus can be kept in operation by diverting the flow of heated oil coming from the heating tubes B into the other vaporizing chamber D^1 by the opening of valve C^3 and the vapors passed therefrom by the opening of valve E^3, and the unvaporized portion in tank D^1 being drawn off through valve D^5 through line D^4 and the discharge of the heated oil into tank D being stopped by the closing of valves C^2 and E^2. In due time, the manholes marked D—D on this latter tank can be opened and the tank cleaned; said tank will be ready to be put back in service by the time it becomes necessary to clean tank D^1, this being done by the closing of valves C^3, and E^3 and the opening of valves C^2 and E^2. These vapor chambers are supported by supports marked X. Said vaporizing chambers and vapor line marked E and section of vapor line marked E^1 are heavily insulated as indicated by D^{31}. The purpose of such insulation is for preventing loss of heat from this section and to prevent any portion of the oil, after once being vaporized, from condensing and mixed back with that portion remaining in the vapor chamber unvaporized. These vapor chambers are maintained only partly full of oil.

It will be noted that the raw oil is fed into the top or last pool of oil, which is of the lowest temperature and flows from there into the next succeeding pool of oil, which is higher in temperature and then to the next, which is still higher, etc. thus being progressively subjected to increasing temperatures and also mixed with such oils as are condensed in these pools of oil and such mixture returned for further heating. Thus, the raw oil being fed in is being preheated before passing to the heating coils B and thus utilizing more or less of the heat given up by the vapors that are passed through these pools of oil. It will be noted that by this novel arrangement, such portions of the oil, either of the raw oil fed in or that formed by condensing of portions of the vapors as they pass through the different pools of oil that are changed to the desired low boiling point products, pass through the water condenser, and are condensed and collected separately, thus avoiding the necessity of subjecting them to the heat of the furnace A^6.

Among other advantages of this process is controlling the amount of cracking done on each circuit of the oil through the heating or cracking tubes B, the separation and withdrawal from the apparatus of the unvaporized portion remaining in the vapor chamber along with more or less of the carbon formed, the fractional condensing of the vapors generated and those of not sufficient low boiling point returned to the heating tubes for further heating and cracking, thus being entirely freed from any carbon content before being passed again through said heating tubes and in each circuit of the oil and vapors through the apparatus, that portion that is again passed through the heating coils is always free of all carbon before being subjected to further heating cracking action.

It will also be observed that in this arrangement, great economy in fuel will be gained. The temperature to which the oil is heated may vary from a minimum of 200 degs. F. to 600 degs. F., and from a maximum of 600 degs. F. to 1500 degs F. While the pressure maintained may vary from minimum of a few pounds to the square inch to a maximum of 800 pounds to the square inch. These ranges of temperature and pressure are by no means arbitrary.

While I have shown and described a particular apparatus for carrying out my method, the latter is not limited to the use with the particular apparatus shown and described. Also various changes in the details of construction, connections and operation of the apparatus may be made within the scope of my invention.

I claim as my invention:

1. A process of oil conversion which consists in passing hydrocarbon oil but once through a continuous elongated passageway where the oil is subjected to a cracking temperature, in introducing the highly heated oil to an enlarged chamber with which said passageway communicates, in discharging the vapors from said chamber to a dephlegmator, in introducing charging stock to the dephlegmator to intimately commingle with said vapors to condense the heavier vapors and heat the stock, in discharging uncondensed vapors, in returning to the inlet side of said elongated passageway intermingled condensate and charging stock for passage therethrough, in withdrawing carbon, con-

taining residue from said enlarged chamber without permitting any portion thereof to again enter the elongated cracking passageway, and in maintaining a superatmospheric pressure on said system.

2. A continuous process of oil conversion, consisting in passing oil in a stream once through an elongated passageway where said oil is subjected to a cracking temperature, in passing the highly heated oil to an enlarged expansion chamber where a substantial portion thereof vaporizes, in discharging vapors directly from said chamber to a dephlegmator, in substantially continuously introducing charging stock to said dephlegmator to intimately commingle with the vapors passing therethrough to condense the heavy oil vapors in discharging uncondensed vapors from said dephlegmator, in continuously returning condensate with intermingled heated charging stock to the inlet side of the elongated cracking passageway for passage therethrough for treatment, and in maintaining a superatmospheric pressure in said system.

3. A continuous process of oil conversion, consisting in passing oil in a stream through a continuous elongated passageway where said oil is subjected to a cracking temperature, in then passing the said highly heated oil to an enlarged expansion chamber where a substantial portion thereof vaporizes, in discharging the vapors from said chamber to a dephlegmator, in substantially continuously introducing charging stock to said dephlegmator to intimately commingle with the vapors passing therethrough to condense the heavy oil vapors, in continuously returning intermingled condensate and charging stock to the inlet side of the elongated cracking passageway for passage therethrough for treatment, in separately discharging residue from said expansion chamber without permitting said residue to enter the elongated cracking passageway, and in maintaining said system under a superatmospheric pressure.

4. A process of oil conversion, comprising passing hydrocarbon oil once only through a continuous elongated passageway where said oil is subjected to a cracking temperature, in then delivering the highly heated oil to an enlarged chamber, in then passing vapors from said chamber to a dephlegmator, in introducing liquid oil to said dephlegmator to condense the heavier vapors, in passing said condensate and heated liquid oil substantially continuously and without previous mixture with the hydrocarbon products in said enlarged chamber to the inlet side of said elongated passageway for treatment therein, in discharging uncondensed vapors from the dephlegmator for final condensation, and in maintaining a superatmospheric pressure on the oil in said passageway, enlarged chamber, and dephlegmator.

5. A process of oil conversion, comprising passing a stream of hydrocarbon oil through an elongated passageway where said oil is subjected to a cracking temperature, in delivering the highly heated oil to an enlarged vapor chamber where vaporization thereof occurs, in then passing vapors from said chamber to a dephlegmator, in introducing charging stock to said dephlegmator to condense the heavier vapors, in passing said condensate and heated charging stock continuously and without previous admission to the vapor chamber to the inlet side of said elongated passageway for treatment therein, in discharging uncondensed vapors from the dephlegmator for final condensation, in separately withdrawing residue from said vapor chamber without permitting said residue to enter said elongated passageway, and in maintaining a superatmospheric pressure on the oil undergoing distillation and while in the dephlegmator.

6. A process of oil conversion, consisting in passing hydrocarbon oil in a stream through an elongated continuous passageway where said oil is subjected to a cracking temperature, in passing the highly heated oil to an enlarged chamber, in discharging vapors from said chamber into a dephlegmator, in introducing charging stock to said dephlegmator, in causing the vapors to percolate through oil pools in said dephlegmator where the heavier vapors are condensed, in continuously admitting to the inlet side of said elongated cracking passageway the intermingled reflux condensate and charging stock for passage through the elongated passageway, in removing heavy carbon containing residue from said vapor chamber without returning said residue to said elongated continuous passageway, and in maintaining a superatmospheric pressure in the system.

7. A process of oil conversion comprising passing hydrocarbon oil in a stream once only through a continuous elongated passageway disposed within a furnace where said oil is subjected to a cracking temperature, in transferring the highly heated oil to an enlarged chamber where vaporization of a substantial portion thereof occurs, in discharging vapors from said chamber to a dephlegmator, and in aiding in the condensation of the insufficiently cracked vapors passing through said dephlegmator by introducing to the dephlegmator incoming charging stock, in passing the condensate from said dephlegmator and the charging stock to the inlet side of said elongated passageway to travel therethrough in a continuously advancing stream to be heated to a cracking temperature, in discharging uncondensed vapors from the dephlegmator for final condensation, and in maintaining a

superatmospheric vapor pressure on the oil in said passageway, enlarged chamber and dephlegmator.

8. A continuous process of oil conversion, consisting in maintaining a treated body of oil heated at a cracking temperature in an enlarged expansion chamber where vaporization of said oil occurs, in discharging said vapors to a dephlegmator for passage therethrough, in condensing the heavy insufficiently cracked vapors in said depblegmator by introducing charging stock thereto, in discharging uncondensed vapors from said dephlegmator, and in then heating said charging stock and condensate from said dephlegmator to a cracking temperature for introduction to said expansion chamber by continuously admitting the same to the inlet side of continuous elongated conveying means disposed within a heating furnace to flow therethrough once only and to be discharged after said single passage into said expansion chamber, in discharging residue from the expansion chamber without admitting the same to said elongated conveying means, and in maintaining a superatmospheric pressure on the oil undergoing distillation and while passing through said dephlegmator.

CARBON P. DUBBS.

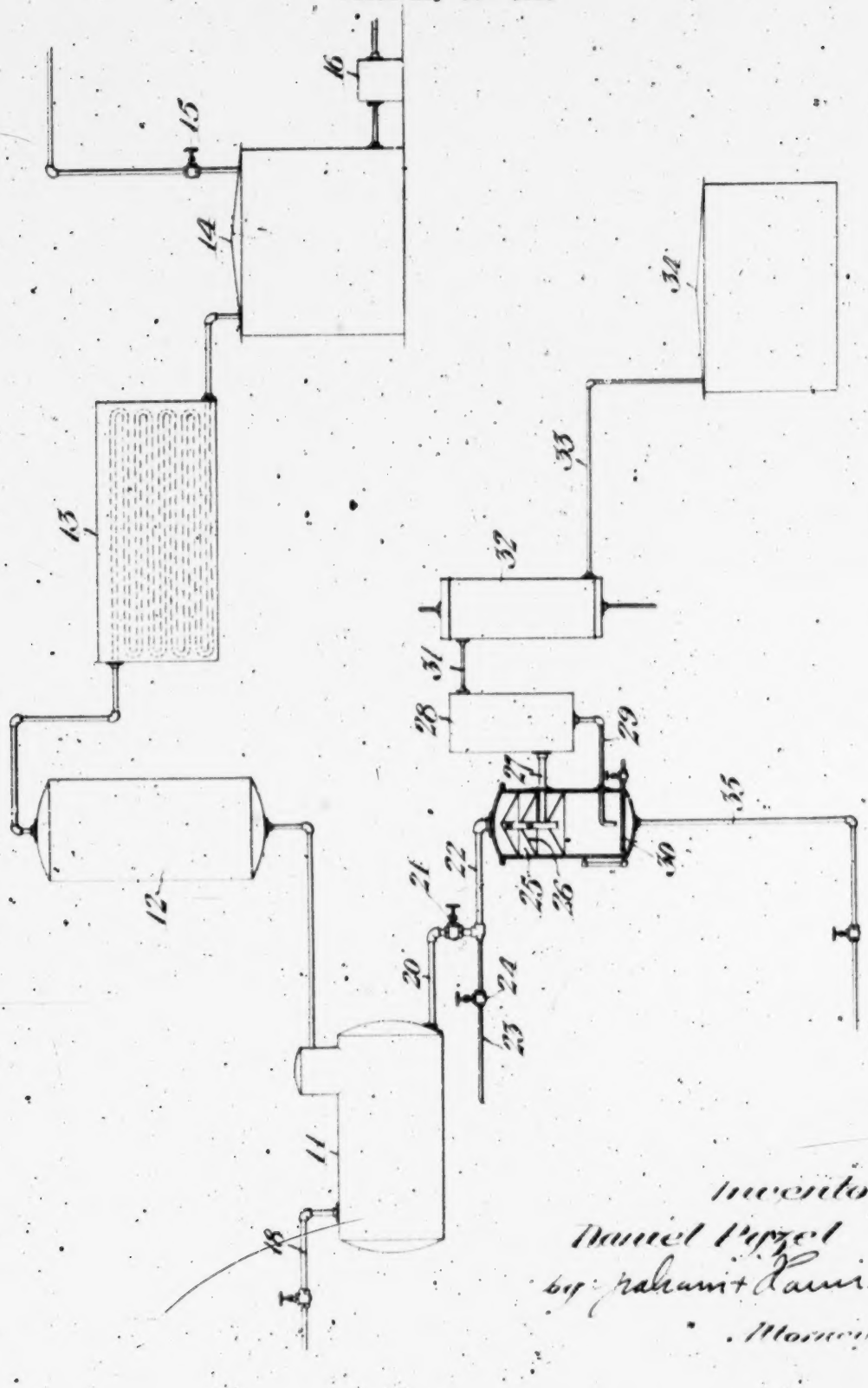
3424

Aug. 26, 1924. 1,506,444

D. PYZEL

PROCESS OF REFINING OIL

Filed May 18, 1921



Inventor
Daniel Pyzel
by: Jackson & Davis
Attorneys

Patented Aug. 26, 1924. 3425 1,506,444

UNITED STATES PATENT OFFICE.

DANIEL PYZEL, OF PIEDMONT, CALIFORNIA.

PROCESS OF REFINING OIL.

Application filed May 18, 1921. Serial No. 470,542.

To all whom it may concern:

Be it known that I, DANIEL PYZEL, a subject of the Queen of Holland, residing at Piedmont, county of Alameda, and State of California, have invented a new and useful Process of Refining Oils, of which the following is a specification.

My invention relates in general to processes used for refining petroleum oils and has a particular utility when applied to cracking processes.

The principal object of the invention is to provide an improvement in cracking processes by which the deposition of carbon in the cracking apparatus is prevented so that the cracking process may be carried on indefinitely.

A further object of the invention is to provide means for conserving heat and therefore promoting a greater economy in such processes.

Further objects and advantages will be made evident hereinafter.

Referring to the drawing which is a diagram showing one embodiment of my invention, 11 is a cracking still, 12 is an air cooler or dephlegmator, 13 is a condenser, 14 is a receiving tank, 15 is a pressure regulating valve and 16 is a trap. The members 11 to 16 constitute a typical cracking apparatus such as is now in use in many places and this embodiment is selected merely for illustrative purposes. Its method of operation is as follows:

The still 11 is charged with the oil which it is desired to crack and is raised to a cracking temperature, the vapors passing into the air cooler or dephlegmator 12 and from thence into the condenser 13, from thence to the receiving tank 14, pressure being maintained on the entire system by means of the valve 15. During the cracking, vapor is taken off from the cracking still 11 and the oil vaporized may be replaced by fresh oil through an inlet pipe 18, the quantity of oil in the cracking still being kept fairly constant.

I have found that when apparatus such as that described is operated in the manner described that in the course of time the accumulation of carbon in the still 11 makes it necessary to shut down the still and discharge the residuum carried therein. In other words, to run on the "batch" system. This is troublesome, and expensive due to the necessity of shutting down the plant during the discharge and refilling of the still 11.

For the purpose of rendering a process of the above described nature continuous, I provide a pipe 20 which has a constricted opening or a partially closed valve 21. The oil in the still 11 is ordinarily carried at a high temperature and at a considerable pressure. The size of the orifice in the valve 21 is such that a portion of this oil is continuously discharged through this orifice, the pressure being relieved in passing through the valve 21 so that the hot oil enters a pipe 22 a little above atmospheric pressure but at an elevated temperature. I prefer to introduce superheated steam through a pipe 23 controlled by a valve 24 into the flowing body of oil in the pipe 22. Due to the reduction in the pressure on the oil and the addition of steam thereto, there is an immediate distillation therefrom, a foam being formed in the pipe 22 the oil therein carrying oil vapors in the form of bubbles. This foam is delivered into the top of a vapor separating chamber 25 which may be of any convenient form. That shown consists of spreader cones 26 which tend to deflect the oil and throw it against the inner walls of the chamber in the form of a thin film from which the vapor may escape, this vapor being taken through a vapor pipe 27 into a dephlegmator 28, the heavier portions of this vapor being condensed therein and delivered through a pipe 29 into the bottom of the vapor separating chamber 25 which may be supplied with a steam coil 30 so that a redistillation takes place therefrom. The vapor not condensed in the dephlegmator 28 is carried through a pipe 31 into a condenser 32 being delivered through a pipe 33 into suitable storage 34.

I have found that in the operation of cracking stills, the temperature must be maintained at such a high point that a considerable portion of the residuum delivered through the pipe 20 is vaporized as soon as the pressure is relieved, this vaporization being assisted by the addition of steam. In the separating chamber 25, these vapors are taken off, a greater portion being eventually delivered into the storage tank 34. The very heavy residuum which remains, which ordinarily contains considerable free carbon and tarry matter, is delivered through a pipe 35. By continuously leading from the cracking still 11 a small stream of the heavy

oil carried therein, I am able to continuously remove from the cracking still free-carbon at a definite rate. By suitably regulating the size of the orifice 21, I am able to make this rate of removal equal to the rate of formation of carbon in the cracking still 11, this carbon eventually appearing together with heavy tars and asphaltic matter in the pipe 35. By the use of my invention which comprises the apparatus 20 to 35 in combination with an ordinary cracking still, I am able to render this cracking still continuous in its operation. I am also able to prevent a formation of carbon deposits therein as I prevent formation of heavily concentrated carbon solutions.

I claim as my invention:

A process of cracking oil which comprises: maintaining a main body of oil at a cracking temperature and pressure; continuously taking off vapors therefrom; continuously supplying fresh oil to maintain the volume of said oil undergoing said cracking; continuously withdrawing oil from said body of oil for the purpose of preventing any increase of the free carbon therein over a predetermined proportion; injecting steam into the oil so withdrawn to form a foam, and thereafter spreading this foam in a thin film after relieving the pressure thereon and while the same is still at substantially the cracking temperature of said main body of oil; and continuously withdrawing vapors from the oil so withdrawn after said pressure has been relieved.

In testimony whereof, I have hereunto set my hand at the city and county of San Francisco, California, this 11th day of May, 1921.

DANIEL PYZEL.

1575496

3428

May 18, 1926. 1,585,496

R. C. HOLMES ET AL

PROCESS FOR MAKING GASOLINE

Original Filed Nov. 21, 1918

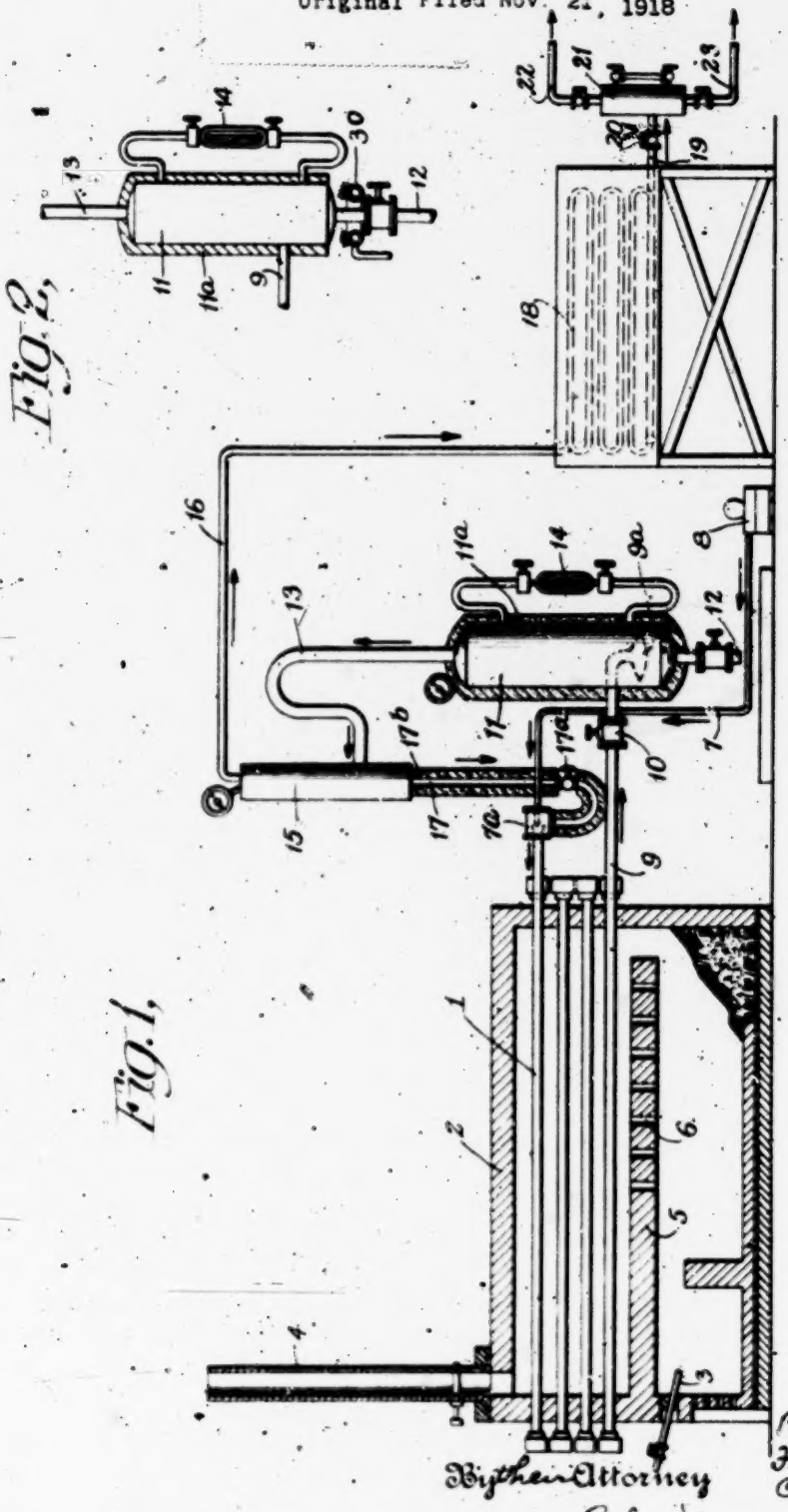


Fig. 2.

Fig. 1.

Inventors
R. C. Holmes
F. T. Manley
O. Behimer

By their Attorney
R. J. Dearborn

Patented May 18, 1926. 3428 1,585,496

UNITED STATES PATENT OFFICE.

RALPH C. HOLMES, OF NEW YORK, N. Y., FREDERICK T. MANLEY, OF HOUSTON, AND OTTO BEHIMER, OF PORT ARTHUR, TEXAS, ASSIGNORS TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF TEXAS.

PROCESS FOR MAKING GASOLINE.

REISSUED

Original application filed November 21, 1918, Serial No. 263,562. Divided and application filed April 6, 1923, Serial No. 630,242. Divided and this application filed August 13, 1925. Serial No. 49,963.

This invention relates to methods of making condensable light oils, such as gasoline. More particularly it relates to certain novel improvements in the cracking of hydrocarbons whereby higher boiling hydrocarbons are decomposed into those of lower boiling point.

This application is a division of our copending application, Serial 630,242, filed April 6, 1923, which itself is a division of our copending application, Serial 263,562, filed November 21, 1918.

In prior methods of cracking hydrocarbon oils, considerable difficulty has been experienced on account of carbon formations, which occur on the sides of tubes and stills exposed to the heat required to carry on the cracking operation.

It is a broad novel feature of the herein disclosed process that substantially all of the cracking operation occurs in a vessel to which no external heat is applied, except at such times and in such quantities as are necessary to compensate for heat losses, the oil prior to its introduction to such vessel having been subjected to a high degree of cracking heat and the excess heat of the oil itself being used to effect its own decomposition. As a consequence, we avoid substantial carbon formation of the destructive character which have proved such an impediment to prior systems. The removal of the cracking operation from the heating zone also reduces the danger from fires such as frequently occur where cracking is carried on in highly heated stills and coils exposed to direct heat.

More specially our process preferably embodies a novel cyclic system in which a circuit of oil is constantly maintained under varying liquid and vapor phases. The oil to be treated on entering this circuit is subjected to a high degree of heat but the time element is so controlled with respect thereto that there is comparatively little decomposition and deposition of carbon while it is exposed to this external heat, the oil being rapidly removed from the heating zone and conducted to the cracking zone, where without necessarily being subjected to additional heat, it undergoes a molecular decomposition whereby carbon and light products are formed and liberated. It will be understood that oil cracking or conversion is dependent not only upon the relative conditions of pressure and temperature but also upon the time element with respect thereto, that is, the necessary pressure and temperature must be maintained for a sufficient period of time to enable the molecular decomposition or conversion to take place. According to the present invention, this time factor is so controlled, by regulating the rate of heating the oil passing through the heating zone that the temperature thereof is progressively raised in transit and reaches the desired cracking temperature near the end of the heating coil at about the time or a little before the oil emerges therefrom. Thus, although the oil is subjected to cracking heats in the heating zone, this temperature is attained only just previous to the exit of the oil therefrom, and therefore, the oil leaves the heating coil before any substantial decomposition and incident deposition of carbon takes place. Subsequently, the highly heated oil in a state of incipient decomposition, is delivered to the cracking zone, where the desired temperature and pressure conditions are continuously sustained and the cracking of the oil and the incident decomposition of carbon are effected. The bulk of the carbon is removed from the circuit by withdrawing from the cracking zone, portions of the residual oil. Although the process, in its broad conception, is complete at this stage of the operation, the light products *preferably continue the* cycle, leaving the cracking zone in the form of vapor and gas. These vapors and gases are then subjected to a reduction in temperature, whereby the heavier constituents thereof, such as kerosene, are condensed. The condensate preferably is combined with the charging oil entering the heating zone, thus completing the cycle. The constituents of the desired volatility are removed from the circuit and condensed. The outlets from the circuit are so controlled that the entire system is maintained under a pressure sufficient to insure the desired molecular transformation.

Our process is to be distinguished from

those of the prior art, in which a circuit of liquid residuum is kept in circulation. When such oil is kept in circulation, considerable quantities of carbon are formed, owing to the readiness with which this type of oil carbonizes when exposed to high temperatures, the carbon forming in fine particles in the oil, and wherever it comes in contact with the heated metal surfaces, it attaches itself thereto and builds up deposits, which often cause the choking of tubes and coils. It also crystallizes the metal surfaces, thereby decreasing the tensile strength of the metal and causing the bulging and breaking of such surfaces. Any residual oil resulting from the cracking operation will necessarily contain a considerable amount of heavy polymerization products and carbon held in suspension in the oil, and to circulate such a residue through heated tubes is to continually pass into or produce in such tubes a large amount of free carbon. In our system, we do not circulate a residuum, but instead keep the residual oil removed from the application of external heat and withdraw the heavier portions thereof, which contain the bulk of the carbon, from the cycle at the cracking zone, and continue the cycle by means of the vapor generated, which contains the condensable product desired and also certain heavier vaporous constituents which are used to complete the cycle. By removing the heavier residuum from the cycle, we keep the circuit free from this source of carbon formation, and since we conduct substantially all of the cracking in a vessel to which either no external heat is applied or only a small quantity of heat is applied to maintain the requisite temperature conditions, we are thus able to effectively remove the carbon formed.

In cracking oil for gasoline, there is generally formed a considerable quantity of vapors heavier than gasoline, which may be generally designated by the term, kerosene. We preferably employ these heavier vapors as a carrier for the lighter vapors; they assist in maintaining a current of vapor by which the gasoline is removed from the cracking zone to a separator where the kerosene vapors are condensed and removed from the gasoline vapors which pass on to the condenser. The kerosene condensate, preferably at a temperature, not materially below its boiling point, is injected or otherwise suitably forced into the heavy oil charge entering and flowing through the heating tubes whereby a foamy agitated mixture is produced by the acceleration of the circulation in the heating tubes resulting from the increased volume of oil therein, thereby preventing the settling and flow of the heavier portions of the oil along the bottom of the highly heated tubes and the consequent local overheating and carbonization of the oil, thus keeping the tubes substantially free from any slight carbon formations. These kerosene constituents are an excellent mechanical conductor of heat, and there is thus produced a heat cycle which materially assists in maintaining the proper temperatures in the heating and cracking zones. By maintaining these bodies in constant circulation, the kerosene constituents, which under existing methods have been found so difficult to decompose into lighter products, are, in our system, ultimately reduced to gasoline.

We have devised certain novel apparatus which is adapted for carrying out our process, and illustrates the preferred form thereof in the drawings in which,

Figure 1 is a diagrammatic elevation of said apparatus;

Figure 2 is a detail view of a modified cracking drum which may be substituted for that of Figure 1.

It will be understood that other apparatus besides that illustrated may be used in carrying out our process.

Referring to Fig. 1 of the illustrative drawings, a tubular heating coil 1 is located in a furnace 2, having a burner 3 and a stack 4. As shown for illustrative purposes, the coil 1 comprises a plurality of horizontally disposed rows of tubes extending through the furnace and placed the one above the other. The adjacent ends of each alternate pair of tubes in each horizontal row are conveniently connected together by horizontally positioned return bends or fittings to form horizontal coils. The several horizontal coils thus arranged are conveniently connected together at their right-hand ends by vertically disposed return bends or fittings, as shown in Fig. 1, to form a single elongated and continuous heating coil through which the oil flows and is heated to the required degree. This coil is of extended length and restricted cross-section and has a relatively large and effective heating surface whereby the stream of oil passing therethrough is enabled to efficiently absorb heat and reach a high temperature with rapidity. A checkered brick baffle 5 having openings 6 may serve to distribute the heat evenly over the coil. A fresh oil charging line 7, having a jet or injector 7ª, extends to a pump 8, which is connected to a suitable source of oil supply (not shown). The pipe 9, having a valve 10, extends from the heating coil 1 to an enlarged cracking drum or chamber 11, within which it may terminate in a distributor 9ª. This distributor 9ª may be of any suitable form to thoroughly distribute and diffuse the charging oil throughout the body of oil in the drum whereby an intimate contact of the highly heated charging oil with the body of oil in the drum is effected. The cracking drum is preferably provided with a jacket 11ª of suitable in-

sulating material to protect it against heat radiation and is equipped with a valved draw-off 12, a vapor outlet 13, and an oil gauge 14. The vapor outlet 13 extends to a separator 15, having a vapor outlet 16, and a condensate outlet 17. The vapor line 16 terminates in a water-cooled condenser coil 18, having an outlet 19 equipped with a regulatable pressure valve 20. If desired the valve 20 may be placed in the vapor line 16 but we prefer to maintain the pressure in the heating coil, cracking drum and separator through the condenser. The outlet 19 terminates in a collecting tank 21, having a valved gas outlet 22 and a valved distillate outlet 23. The condensate line 17, which is preferably insulated, as indicated at 17^b is equipped with a valve 17^a and is connected to the charging line 7 at the jet 7^a.

In conducting the process with the apparatus illustrated, the oil to be treated is forced through the charging line 7 under considerable pressure, and is rapidly flowed through the heating coil 1, where it is heated to the desired cracking temperature. Preferably this temperature is somewhat higher than the temperature at which it is desired to conduct the cracking operation and may or may not result in substantial vaporization. The oil on being forced through the coil acquires a high cracking temperature, but on account of the rapidity of its flow, decomposition is only in the incipient stages when the oil is discharged through the pipe 9 into the heat insulated cracking drum 11 where a constant body of oil is maintained at a cracking temperature under pressure. The distributor 9^a, if employed serves to discharge the oil into the cracking drum in a wide stream, thus thoroughly mixing the hot oil with the liquid body of oil maintained in the drum and diffusing the heat therethrough. This heat diffusion is materially aided by using a distributor with serrated edges. The rapid flow of the oil through the coil where it is closely confined is here suddenly retarded, as the oil enters the drum which is of ample volume. Thus the excess heat of the oil operates to maintain the body of oil at the desired cracking temperature and molecular decomposition and distillation are carried on vigorously, the higher boiling hydrocarbons continually breaking up into hydrocarbons of lower boiling point. The vapors and gas generated gather in the upper part of the cracking drum and pass out through the vapor outlet 13 to the separator 15, where there is effected a separation of hydrocarbons of desired volatility from those of less volatility. The hydrocarbons of the desired volatility pass out through the vapor line 16, by which they are conducted to the condenser 18, where they are condensed, and the condensed distillate is either intermittently or preferably continuously allowed to run into the collecting tank 21.

The temperature in the air condenser 15 is such that the less volatile hydrocarbons are condensed and dropped into the conduit 17, by which they are conducted while still hot to the jet in the charging line or other suitable device for forcing the condensate into the charging stream. The separator is preferably somewhat elevated so as to give a considerable head of liquid in the pipe 17, which preferably contains a U bend, as illustrated, in order to form a liquid seal therein. This head of liquid, together with the high pressure at which the oil in the charging line passes the jet, this pressure being ordinarily from 50 to 100 pounds higher than the pressure in the drum, insures that the condensate shall be constantly and positively drawn into the charging line and forced into the coil 1. The introduction of this hot condensate into the charging line increases the volume of oil in the heating coil and thereby accelerating the flow therein and producing a foamy mixture so that local overheating is prevented and the coil is kept substantially free from any slight carbon formations. This condensate consists in a type of hydrocarbon which when decomposed does not yield any great amount of carbon so that the oil charge is constantly being diluted with oil capable of being decomposed into lighter products without the production of large amounts of carbon. This condensate reaches the jet in a heated condition, preferably at a temperature not materially below its boiling point, so as to heat the charge of oil entering the heating coil. The heat cycle formed by the kerosene constituents contributes to the maintenance of the proper temperatures in the heating coil and the cracking drum. By injecting or otherwise suitably forcing this condensate into the heating coil we increase the volume of oil flowing therein without increasing the total amount of oil charged into the system at any given time.

A considerable pressure is maintained throughout the system, which pressure is regulated by means of the valve 20 or the valve on the gas outlet 22. The pressure used varies with the character of the oil operated on and the character of the product desired. Ordinarily the decomposition in the cracking drum is carried on under a pressure of from 100 to 400 pounds. In utilizing oils of the type commonly employed for decomposition into products of the nature of gasoline a temperature in the drum 11 of from 700° F. to 850° with a temperature in the coil 1 of from 700° F. to 950° F. is ordinarily used. For example, in cracking a paraffin base gas oil of a Baumé gravity of about 34°, a temperature

of 850° F. in the coil and of 775° F. in the drum with a pressure of approximately 200 pounds has been used to advantage.

The oil to be decomposed is constantly forced into the heating coil thereby causing a steady stream of heated oil to enter the cracking chamber. The residuum is withdrawn preferably at such a rate that there is maintained a constant body of oil in the cracking zone.

It is desirable to equip the apparatus with the valves 10 and 17 so that in case there is a break in the heating coil the effect of any fire resulting may be localized by closing said valves, whereby the bulk of oil in the system will be retained in the cracking drum 11. It is understood that in the normal operation of the process these valves are open.

Auxiliary heat may be supplied to the cracking drum in any suitable manner if desired, and a convenient method of providing this auxiliary heat is, as shown in Fig. 2, to insulate only the upper part of the drum and apply heat at a moderate temperature or in a relatively small quantity from any suitable heater such as is designated 30. In the early stages of a run, since there is no danger of overheating a carbon-free surface, the drum may be heated freely until the necessary heat cycle has been generated and decomposition has begun. For this reason the arrangement of Fig. 2 possesses certain advantages over that of Fig. 1. But when decomposition begins, with a consequent deposition of carbon, the heat must be reduced, as otherwise the carbon would accumulate on the hot surfaces and build up tenacious formations thereon, thus preventing the effectual removal of the carbon and asphaltic bodies. As the run continues only a moderate heat is applied, sufficient only to offset the loss of heat due to radiation and distillation. If desired the drum may be heated by means of waste heat from the furnace 2 or in any other suitable manner.

The product obtained by the herein disclosed process is, for a cracked product, remarkably sweet, in other words, low in unsaturated compounds.

It is understood that we use the terms gasoline and kerosene in this application by way of example and that these terms are taken as types of other similar distillates which may be produced by our process. We use the term gasoline as an example of the volatile product desired which under the temperatures and pressures used is a vapor in the separator 15 and is condensable in the cooling coil 18. We use the term kerosene as an example of those constituents which under the temperatures and pressures used is a vapor in the vapor line 13 but is condensable in the separator 15. It is to be noted that the gravity and boiling point of the products which will condense in the separator 15 depends upon the temperature therein under the pressures used.

Although for illustrative purposes the invention has been shown and described in connection with apparatus of more or less specific details of construction, arrangement and location of parts, and as embodying in its mode of operation a certain series and sequence of somewhat definite steps and operating conditions, it will be understood that many of the objects and advantages of the invention may be obtained, to a greater or less extent, through the employment of apparatus of modified character or, in fact, through variations or, in some cases, omissions, of certain of the component steps, without departing from the spirit and scope of the invention.

What we claim is:

1. The process of converting hydrocarbon oil which comprises forcing said oil through a coil and drum while applying heat to said coil and drum and allowing the vapors generated to develop pressure until decomposition of the hydrocarbon begins, then reducing the heat applied to the drum while securing it against substantial loss of heat through radiation and vaporization, and continuously supplying to the oil in the drum the necessary heat for decomposition by means of the stream of oil entering from the coil, the stream entering the coil being continuously commingled with a hot condensate separated out from the generated vapors.

2. The process of converting hydrocarbon oil which comprises forcing said oil through a coil and drum while applying heat to said coil and drum and allowing the vapors generated to develop pressure until decomposition of the hydrocarbon begins, then reducing the heat applied to the drum while securing it against substantial loss of heat through radiation and vaporization, and continuously supplying to the oil in the drum the necessary heat for decomposition by means of the stream of oil entering from the coil.

3. The process of converting hydrocarbon oil that comprises forcing a stream of oil through an elongated passageway of restricted cross-section and thence into an enlarged chamber while applying heat freely to both said passageway and said chamber to rapidly raise the oil to a cracking temperature and develop a superatmospheric cracking pressure therein and, after said conditions of temperature and pressure have been attained, applying to said enlarged chamber reduced or moderate heat sufficient only to maintain a cracking temperature in said chamber while continuing the free application of heat to said passageway.

4. The process of converting hydrocarbon il that comprises passing a stream of oil hrough an elongated passageway of re-tricted cross-section, and then delivering it nto an enlarged zone where a body of oil is naintained, freely heating the oil in said assageway and in said enlarged zone dur-ng the starting period until cracking condi-ions of temperature and pressure are estab-ished, and subsequently continuing the free eating of the oil in said passageway but pp'ying to the body of oil in said enlarged one a reduced and moderate amount of heat ufficient to offset heat losses and to maintain cracking temperature therein throughout he period of normal operation.

5. The process of converting hydrocarbon il that comprises freely heating a moving tream of oil in its passage through a heat-ng coil and distillation drum during the starting period to rapidly establish crack-ing conditions of temperature and pressure therein, then continuing the maintenance of said conditions during the period of normal cracking operations by heating the oil in said drum at a reduced and moderate rate while continuing to freely heat the oil in the coil, removing the vapors from the distilla-tion drum, and separating out and returning to the heating coil the condensed heavier fractions thereof.

In witness whereof I have hereunto set my hand this 23rd day of July, 1925.

RALPH C. HOLMES.

In witness whereof I have hereunto set my hand this 24th day of July, 1925.

FREDERICK T. MANLEY.

In witness whereof I have hereunto set my hand this 25th day of July, 1925.

OTTO BEHIMER.

3436

Aug. 31, 1926. 1,597,821

D. PYZEL

REGULATING APPARATUS FOR CRACKING STILLS

Filed June 25, 1924 2 Sheets-Sheet 1

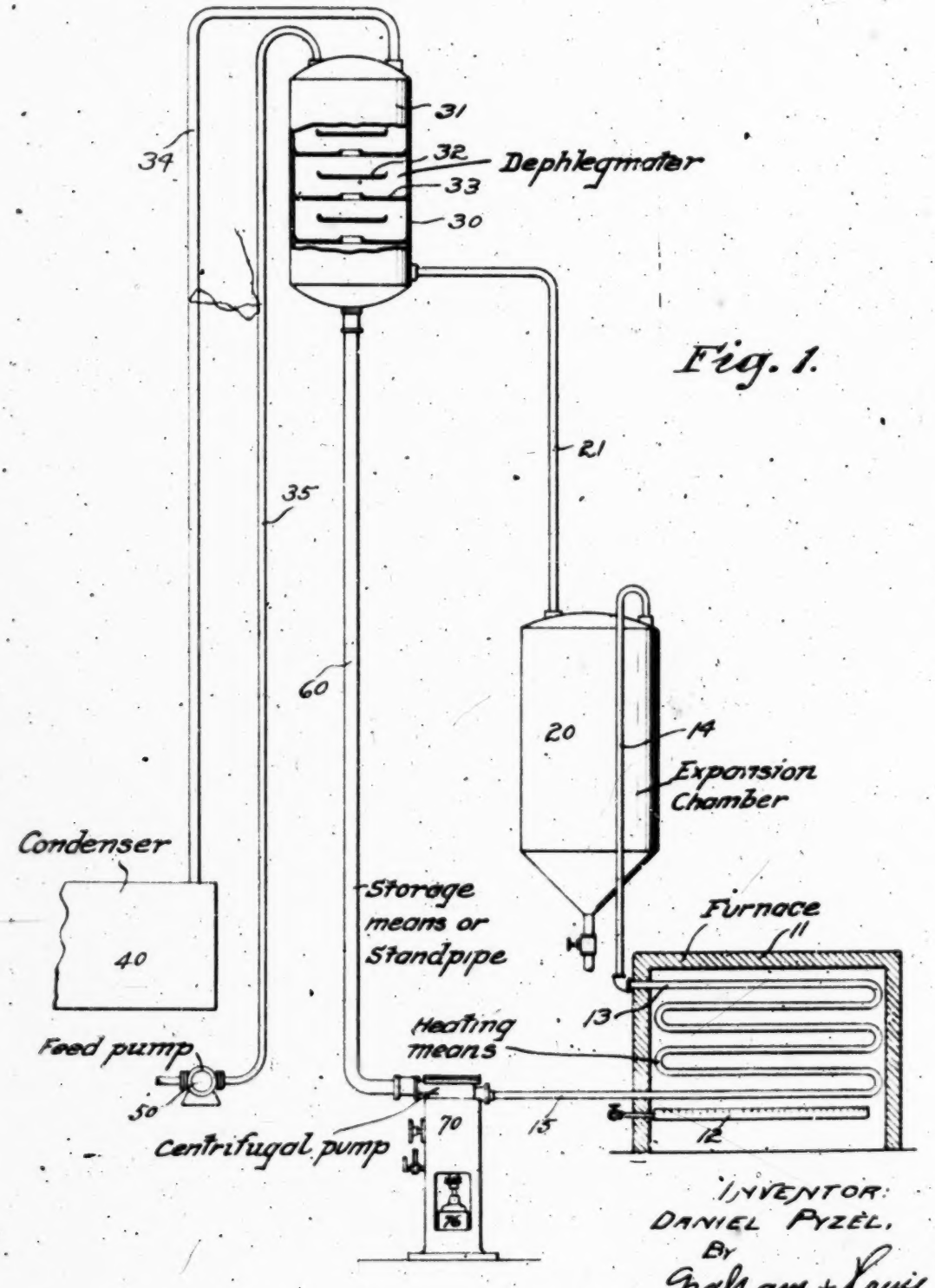


Fig. 1.

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Aug. 31, 1926. 1,597,821

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REGULATING APPARATUS FOR CRACKING STILLS

Filed June 25, 1924 2 Sheets-Sheet 1

Fig. 4.

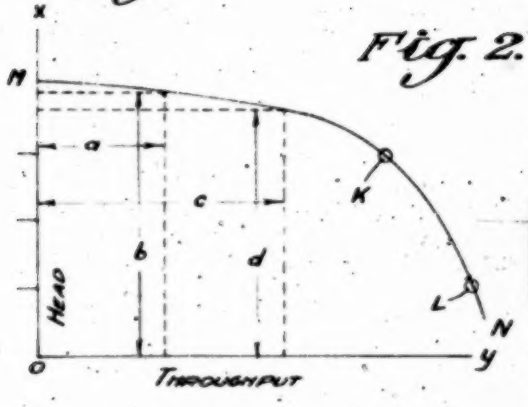


Fig. 2.

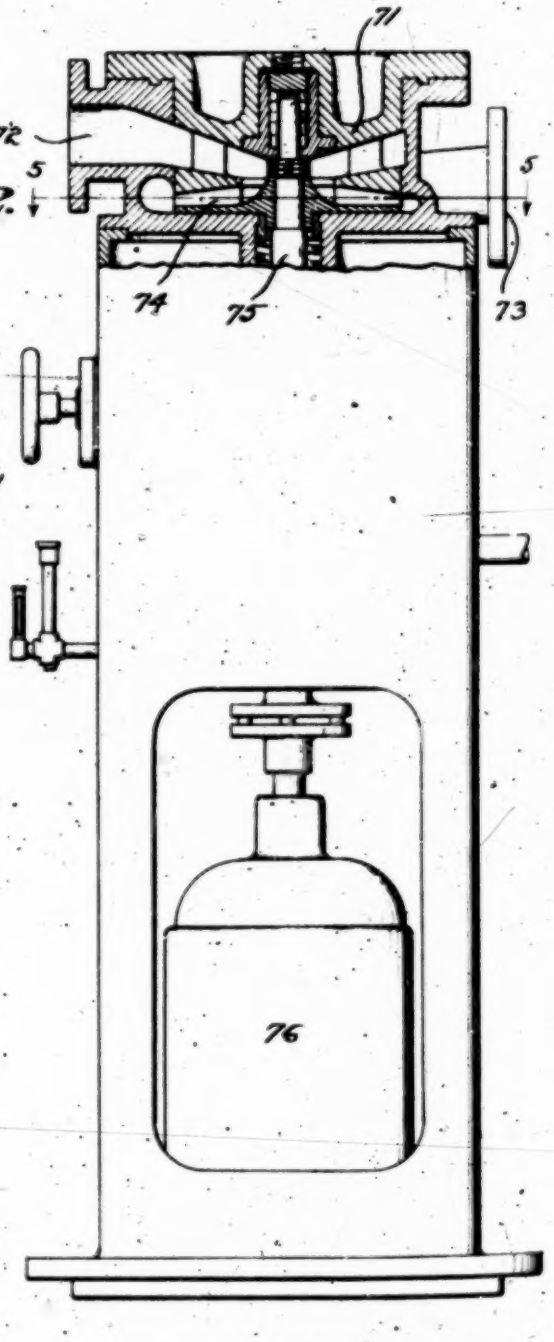
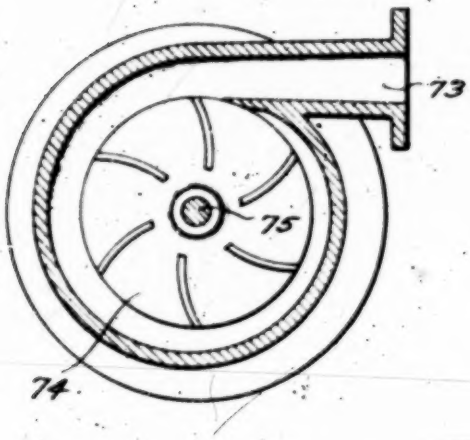


Fig. 3.



INVENTOR:
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3439

Patented Aug. 31, 1926. 1,597,821

UNITED STATES PATENT OFFICE.

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REGULATING APPARATUS FOR CRACKING STILLS.

Application filed June 25, 1924. Serial No. 722,296.

My invention relates to the art of cracking petroleum oils. In that art it is common practice to raise oils to and hold them at a cracking temperature, usually under some pressure, for the purpose of breaking up the oil and producing from cheap and stable oils more volatile hydrocarbons such, for example, as gasoline. There are in use today a considerable number of forms of apparatus capable of cracking oil.

It is an object of my invention to provide means by which the capacity of such apparatus is greatly increased and the operation thereof simplified by providing means for automatically compensating for variable factors found therein.

Further objects and advantages will be made evident hereinafter.

Referring to the drawings which are for illustrative purposes only.

Fig. 1 is a diagrammatic elevation of a plant embodying my invention.

Fig. 2 is an elevation of the pump.

Fig. 3 is a section on the line 5—5 of Fig. 2.

Fig. 4 is a characteristic curve of the pump.

As illustrating one form which my invention may take I show it applied to a cracking plant in which 11 is a furnace which is provided with suitable heating means such as a gas burner 12 and in which is situated a continuous coil of pipe 13 forming a heating means. The upper end of the pipe 13 is connected through a pipe 14 with the top of an expansion chamber 20, this chamber being formed of metal and being of sufficient strength to stand pressure, being perfectly heat-insulated. The upper portion of the expansion chamber is connected through a pipe 21 with the lower portion of a dephlegmator 30. This dephlegmator consists of a tight shell 31 having pans 32 and 33 arranged alternately therein. The pans 33 have a central opening and the pans 32 are somewhat smaller than the interior of the dephlegmator so that an annular opening is left between the edge of the pan and the wall of the dephlegmator. A vapor line 34 leads from the top of the dephlegmator 30 to a condenser 40. Raw oil is fed into the dephlegmator 30 through a feed pipe 35, the oil being delivered thereto from a feed pump 50. The lower portion of the dephlegmator is connected into a regulating stand pipe 60. This stand pipe 60 acts as a storage means for liquid leaving the dephlegmator 30 and is so referred to in the claims without intention to limit the term "storage means" to this actual embodiment.

The above apparatus is all well known in the art and is used very successfully in cracking oil, the stand pipe 60 being ordinarily connected to the inlet end 15 of the heating coil 13. When so connected the raw oil delivered to the dephlegmator by the pipe 35, after passing through the dephlegmator and having portions of its lighter contents vaporized therein, is delivered from the bottom of the dephlegmator to the regulating stand pipe 60. In its passage downwardly through the dephlegmator the oil collects certain heavy condensates from the vapor stream. The mixture of partially treated oil and condensate collects in the bottom of the dephlegmator and passes downwardly into the regulating stand pipe. In the previously constructed plants, the mixture passes through the heating coil 13, and back into the expansion chamber 20.

I have found that the operation of plants of this type is a difficult matter and that the capacity of such plants is small due to the fact that gravity alone is depended upon to force oil from the stand pipe 60 to the heating coil 13. The vapors produced in the apparatus are under such conditions of temperature and pressure that they are close to their critical temperature. As a result the latent heat of vaporization of such vapors is always very low and small changes in conditions in the apparatus will result in wide variations in the amount of condensate produced in the dephlegmator and in the necessary rate of flow in the heating means to remove this condensate from the dephlegmator and its dependent stand pipe.

Some variation in the rate of flow is now obtained by making the stand pipe 60 very long and depending upon the variations in liquid level therein to regulate the flow from the lower end thereof. It is therefore, now the practice to support the dephlegmator on a high tower thus allowing for the use of a long stand pipe and providing for some variation in the rate of production of condensates, the rate of flow to the heating means increasing as the level of the liquid rises in the stand pipe and thus automati-

cally increasing the removal of condensates from the dephlegmator.

This method of providing for automatic operation of the apparatus would probably be satisfactory were it physically practical to elevate the dephlegmators to a sufficient degree. The specific gravity of the liquid in the stand pipe 60 at its elevated temperature is probably about one-half that of water, however, and it is impractical to sufficiently elevate the dephlegmator to provide for the necessary wide variations in condensate production if the apparatus is otherwise operated to capacity. It is therefore the present practice to operate such apparatus at a low rate carefully watching and regulating this rate to prevent excessive production of condensate.

I have found that the capacity of apparatus of this type can be very greatly increased if I supply a pump which takes oil from the stand pipe 60 and delivers it under pressure to the inlet pipe 15 of the heating coil. It is impractical, however, to use an ordinary piston pump driven at a constant speed, for this purpose since where such a pump is used, there is very great liability of the pump drawing all of the liquid out of the stand pipe 60 and pumping vapor therefrom into the heating coil 13. This results in serious injury to the heating coil, since the presence of vapor in the heating coil prevents the heat delivered to the exterior thereof which is ordinarily rapidly absorbed in the liquid therein, from being promptly carried away and the use of piston pumps for this purpose has been previously found to be impractical and dangerous. I have found, however, that by the use of a particular type of pump I am able to use forced circulation without danger and with excellent results.

I utilize the type of pump illustrated in Figs. 4 and 5, this pump consisting of a casing 71 having an inlet opening 72 and an outlet opening 73. A rotor 74 is mounted on a shaft 75 which is driven by a motor 76. Certain specific types of construction have to be adopted when handling very hot oil but these specific forms of construction forming no part of the present invention, need not be referred to herein. The pump is of the centrifugal type. Pumps of this character have the characteristic of automatically reducing their throughput as the differential head against which they operate is increased.

In Fig. 4 I show a characteristic curve of such a pump in which distances on the line $(o)—(x)$ represent values of the differential head against which the pump operates and distances on the line $(o)—(y)$ represent throughput of the pump. The curve MN defines these values. If for example the head is reduced from (b) to (d) the throughput is increased from (a) to (c). Thus a small reduction in the differential head substantially doubles the amount of oil passing through the pump. Also if the differential head is slightly increased from the value (b) to a value represented by the line O—M the throughput falls to zero.

In the apparatus shown, the differential head against which the pump operates is the head of oil in the pipe 14 plus the friction head necessary to move the oil from the stand pipe 60 through the pump 70, the pipe 15, the heating coil 13, and the pipe 14 minus the head of oil. This friction head is variable, increasing with the rate of flow.

While the form of characteristic curve shown in Fig. 4 is representative of many forms of centrifugal pumps it should be noted that in the commercial operation of such pumps they are usually operated on that portion of the curve between the points (K) and (L). By operating the pump on the flat or extreme left hand portion of the curve as shown it is possible so obtain the very desirable characteristics herein utilized.

The method of operation is as follows:

Raw oil introduced through the pipe 35 into the dephlegmator 30 flows downwardly over the pans 32 and 33 absorbing and condensing condensates from the vapors therein, and giving up to these vapors its constituent parts boiling at a point below the temperature of the dephlegmator. The mixture of partially treated oil and condensate flows into the stand pipe 60 and is delivered therefrom to the suction side of the pump 70. The pump forces the mixture through the heating coil 13 and through the pipe 14 into the expansion chamber 20. The expansion chamber 20 is of sufficient capacity to allow the cracking reaction to complete itself therein producing vapors which pass through the pipe 21 into the dephlegmator 30. In the dephlegmator 30 the vapors are sufficiently cooled to cause the stream of raw oil flowing downwardly therethrough to collect and condense all the vapors of condensates boiling above a definite temperature. The remaining vapors of condensates having a lower boiling point pass through the pipe 34 and are condensed, to form the desired low boiling point condensates, in the condenser 40.

The pump 70 automatically regulates the level of the liquid in the stand pipe 60. Should the amount of condensate formed in the dephlegmator increase for any reason the level is raised and the differential head against which the pump operates is accordingly diminished. The pump has such special characteristics that a small reduction in the differential head greatly increases the rate of throughput of the pump and this throughput continues to increase rapidly as

the level in the pipe 60 rises until the rate of throughput is equal to the rate of production of condensates. When these rates are equal further accumulation of liquid in the pipe ceases and a condition of equilibrium is obtained.

If for any reason the rate of production of condensates is then reduced the level of liquid in the pipe 60 starts to fall and the differential head, against which the pump 70 works, is accordingly increased. This rapidly cuts down the rate of thorughput of the pump and should the level fall below a certain critical point the throughput ceases. This, however, cannot occur in practice as long as any liquid is flowing from the dephlegmator 30 into the stand pipe 60.

It will be seen that, owing to the peculiar characteristics of the centrifugal pump 70 it is possible to automatically hold the level of the liquid in the pipe 60 within narrow limits even with wide variations in the rate at which liquid is supplied from the dephlegmator to the pipe 60, the pump 70 automatically increasing its throughput to compensate for an increase in the rate of supply and reducing its throughput to compensate for a decrease.

By the use of my invention apparatus of the character above described operates automatically under all conditions. Due to the fact that the pump 70 will automatically take care of large increases in the rate of condensate production in the dephlegmator 60 it is possible to greatly increase the rate at which raw oil is supplied and therefore to double and in some cases to treble the capacity of a given plant.

I claim as my invention:

1. In an apparatus for cracking oil, the combination with a heating coil, of a reacting zone in communication therewith, a reflux condenser, means for delivering heated vapors from said reacting zone to said reflux condenser, a condensate storage receiver, means for delivering reflux condensate to said receiver, and mechanical pressure applying means acting in response to the level of condensate in said storage receiver for automatically forcing said condensate through the heating tube in a quantity varying with the level of condensate maintained in said storage receiver.

2. An apparatus for cracking oil, comprising a heating coil, a reacting chamber, a reflux condenser in communication therewith, means for delivering the vapors from said reaction chamber to said reflux condenser, a condensate receiver in which a quantity of reflux condensate is maintained, and a pump in communication with said receiver, said pump acting automatically in response to the level of condensate in said storage receiver for delivering condensate to the heating tubes in a quantity varying with the level of condensate in the storage receiver.

3. An apparatus for cracking oil, comprising a heating coil, a reacting chamber, a reflux condenser in communication therewith, means for delivering the vapors from said reaction chamber to said reflux condenser, a condensate receiver in which a level of reflux condensate is maintained, and a constant speed pump in communication with said receiver, said pump acting automatically in response to the level of condensate in said storage receiver for delivering condensate to the heating tubes in a quantity varying with the level of condensate in the storage receiver.

In testimony whereof, I have hereunto set my hand at San Francisco, California, this 14th day of June, 1924.

DANIEL PYZEL.

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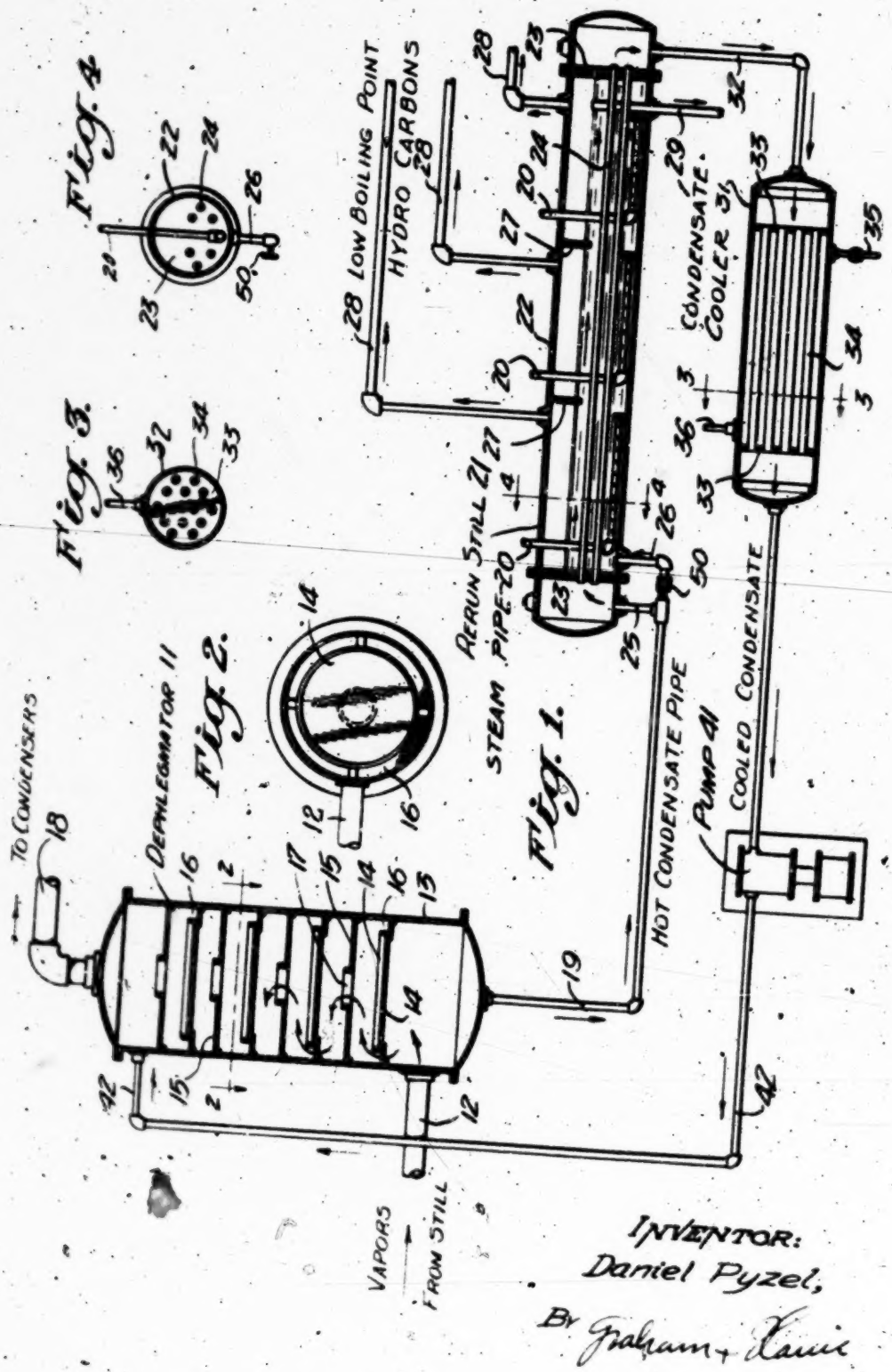
March 29, 1927.

D. PYZEL

1,622,737

PROCESS OF SEPARATING HYDROCARBON FRACTIONS

Filed Aug. 23, 1923



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Patented Mar. 29, 1927.

3445 1,622,737

UNITED STATES PATENT OFFICE.

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PROCESS OF SEPARATING HYDROCARBON FRACTIONS.

Application filed August 23, 1923. Serial No. 658,910.

My invention relates to the art of oil refining and particularly to the art of fractionating oil vapors.

In the art of oil refining an oil vapor is usually produced by the still, this vapor being made up of a complex series of hydrocarbons, the different hydrocarbons having various boiling points.

It is an object of the present invention to provide means whereby a hydrocarbon of definite characteristics can be separated from such a complex mixture.

It is further an object to separate from a vapor containing a complex mixture of hydrocarbons a condensate having a definite range of boiling points, and it is further an object of this invention to separate from such a condensate any hydrocarbons which may be entrained in the condensate as originally formed, and which have boiling points below the desired range.

Further objects and advantages will be made evident hereinafter.

Referring to the drawing which is for illustrative purposes only.

Fig. 1 is an elevation partly in section showing diagrammatically one form of apparatus embodying my invention.

Fig. 2 is a section on a plane represented by the line 2—2 of Fig. 1.

Fig. 3 is a section on a plane represented by the line 3—3 of Fig. 1.

Fig. 4 is a section on a plane represented by the line 4—4 of Fig. 1.

In the form of the invention illustrated I use a dephlegmator 11, a rerun still 21, a cooler 31 and a pump 41. Vapor from an oil still, not shown, is delivered to the dephlegmator 11 through a pipe 12, the dephlegmator consisting of a tight shell 13 in which are placed pans 14 and 15. The pans 14 are smaller in diameter than the shell, leaving an annular opening 16 therearound. The pans 15 fit tightly in the shell and have a central opening 17. The vapor entering the dephlegmator passes in a tortuous course around the pans 14 and through the center of the pans 15, being finally withdrawn through a pipe 18 and delivered to additional dephlegmators or condensers, not shown. Cold condensate is delivered into the top of the dephlegmator through a pipe 42 from the pump 41, being taken through the cooler 31 through a pipe 32 from the rerun still, as will hereinafter be explained. The cold condensate in its passage downwardly through the dephlegmator fills the pans 14 and 15, passing successively down from these pans and into the bottom, from which it is withdrawn through a pipe 19. In its passage through the dephlegmator the cooled condensate acts as both a condensing and an absorbing medium, that is to say it acts upon the oil vapors to cool them, thereby causing the higher boiling point fractions to condense, and it also acts directly, especially in the cooler upper part of the dephlegmator, to absorb from the oil vapors certain of the lower boiling point vapors carried therein. On the other hand the hot vapors in the lower part of the dephlegmator tend to evaporate from the condensate part of the low boiling point oils which are absorbed therein. The vapors condensed or absorbed add to the volume of the condensate and the mixture from the bottom of the dephlegmator 11 is carried through the pipe 19 to the rerun still 21.

This still consists of a tight shell 22 having false heads 23 therein, between which tubes 24 extend. A large portion of the hot condensate is delivered by means of a pipe 25 into the space at one end of the rerun still 21 outside one of the heads 23, this portion of the condensate flowing through the tubes 24 into a space at the opposite end of the rerun still and being taken off therefrom by means of a pipe 32. The other smaller portion of the condensate is delivered through a pipe 26 to the space between the heads 23, flowing from left to right through this space, in which it is in contact with the outside of the tubes 24 through which the larger portion of the hot condensate is flowing. The interior of the space between the heads 23 is divided into several parts by partitions 27 which extend down into the liquid therein, forming separate vapor spaces from which independent vapor takeoffs 28 lead to suitable condensers, not shown. Steam is supplied to these spaces through perforated pipes 20, and the level of the liquid is maintained above the bottom of the partitions 27 by means of the pipe 29, which projects up into the rerun still to the necessary height to accomplish this result. The injection of steam through the perforated pipes 20 causes an evaporation from the body of liquid in the rerun still, the vapors, consisting of the low boiling point fractions, being withdrawn

through the pipes 28 so that the body of condensate in the still is freed of low boiling point fractions. The evaporation of these fractions requires a considerable amount of heat and would reduce the temperature of the liquid in the still below the temperature required for efficiently freeing it from such low boiling fractions. To prevent this, heat is supplied to the liquid in the rerun still by the tubes 24, through which the larger part of the hot condensate from the dephlegmator flows. After giving off part of its heat, through the tubes 24 to the liquid in the rerun still, this condensate is carried off by the pipe 32 to the cooler 31, this cooler having intermediate heads 33, between which tubes 34 extend. Cold water or another cooling medium is delivered to the space between the heads 33 by a pipe 35, the heated cooling medium being withdrawn through the pipe 36. The function of the cooler 31 is to still further cool the condensate which is then forced by the pump 41 through the pipe 42 into the top of the dephlegmator.

A valve 50 is provided in the pipe 26 for the purpose of regulating the proportion of the condensate delivered by the pipe 19 which will be passed through the pipe 26 into the central chamber of the rerun still.

By the use of the dephlegmator 11, it is possible to separate from the vapor all of the condensate which will condense below a certain temperature. At the same time the condensate in the dephlegmator 11 must necessarily contain certain fractions which have a lower boiling point than the desired product. These lower boiling point fractions are re-evaporated in the rerun still and taken over by the pipes 28 so that the condensate delivered to the pipe 29 is free from these low boiling point fractions which are, however, valuable and which are saved and utilized for other purposes. By the use of my invention a condensate having a very definite range of boiling points is continuously delivered through the pipe 29, certain other condensates having lower boiling points being delivered as vapors through the pipes 28.

The vapors delivered through the pipe 12 from the still, not shown, to the dephlegmator 11 consist at any instant of a complex mixture of hydrocarbon vapors, all of which vaporize below the still temperature and substantially none of which require a higher vaporizing temperature. This mixture delivered through the pipe 12 therefore consists of hydrocarbons boiling at a temperature below that of the still.

In the dephlegmator 11 a portion of the vapors are cooled and partly condensed by a circulating stream of cold condensate entering through the pipe 42, the proportion so condensed being determined by the exit temperature of vapors leaving the condenser by the pipe 18. The condensate delivered from the bottom of the dephlegmator therefore consists chiefly of hydrocarbons which will condense below this exit temperature or boil above this temperature. In addition, however, these hydrocarbons of high boiling point will absorb considerable quantities of lighter vapors which normally boil considerably below the exit temperature of the dephlegmator. These lighter vapors, in many cases, when condensed form products which are much more valuable than the condensate itself. For example, the condensate may be chiefly a heavy and relatively low priced gas-oil distillate and the lighter vapors absorbed may be gasoline having a considerably greater value. It is the purpose of the rerun still 21 to remove these lighter vapors from a part of the condensate equal in quantity to the condensate formed in the dephlegmator.

This is accomplished by means of the heat already in the liquid flowing from the dephlegmator 11 through the pipe 19. A portion of this liquid flows through the tubes 24 and a portion surrounds these tubes. Since it is desired to extract heat from the liquid inside the tubes, it is necessary that the temperature of the liquid outside the tubes be lowered. It is obvious that if it is desired to cause an evaporation from the liquid outside the tubes at this lower temperature, it will be necessary to lower the absolute pressure on this liquid, which could be done by means of a vacuum pump, or to lower the partial pressure by the injection of steam, which is the expedient I adopt herein.

By injecting steam into the liquid outside the tubes 24, I not only agitate the liquid but I also produce in the space above the liquid a mixture of steam and oil vapors, and thereby greatly lower the partial pressure of the oil vapors. As a result I am able to evaporate from the liquid in the rerun still all the low boiling point vapors carried therein, this evaporation taking place at a temperature considerably below that of the liquid flowing through the pipe 19.

Due to the reduction in the partial oil vapor pressure inside the rerun still 21, which is due in turn to the presence of steam, I am able to evaporate such low boiling point vapors at this lower temperature, the latent heat of vaporization being supplied by heat conduction from the liquid in the tubes 24.

The function of the injected steam is solely the reduction of the partial oil vapor pressure necessary to cause the liquid to boil, notwithstanding the reduction in temperature caused by the evaporation of its lighter constituents. The temperature of the injected steam is, therefore, immaterial. If it is higher than that of the oil, it will give off a small amount of heat to this oil; if it is lower, it will be heated to the temperature

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of the oil, the heat required for this purpose being supplied by the hotter oil inside the tubes.

Preferably, the steam is supplied at about the same temperature as that of the liquid outside the tubes 24, which is determined by the evaporation of low-boiling point vapors therefrom, and the consequent extraction of heat therefrom.

By allowing the liquid to flow inside the rerun still 21 from left to right, as shown in Fig. 1, and subjecting it to this evaporation under partial pressure, I am able to distill therefrom substantially all the low boiling point hydrocarbons which are delivered as vapor through the pipes 28, so that the liquid finally withdrawn through the pipe 29 is substantially free from such low boiling point hydrocarbons.

It is further to be noted that by regulating the quantity of circulating distillate and by regulating the flow of steam through the pipes 20, the operator can accurately determine the amount of vaporization produced in the rerun still 21 and the character of the liquid delivered through the pipe 29. It will also be noted that this is accomplished by the use of the sensible heat carried in that part of the liquid delivered from the pipe 19 by the pipe 25 to the inside of the heating tubes.

This part of the liquid, after supplying the heat required in the rerun still, is then delivered by the pipe 32 to a cooler 31 where it is further cooled, after which it is pumped back through the pipe 42 to the top of the dephlegmator as a cooling medium.

I claim as my invention:

1. A process of separating hydrocarbon fractions from a heated mixture of said fractions in a liquid state which comprises: lowering the partial vapor pressure on a portion of said mixture by injecting therein vapor having a different vapor tension; supplying heat to said portion from the remainder of said mixture, said remainder being held under its initial vapor tension; and removing the mixture of vapors produced by said injection and heating.

2. A process of separating hydrocarbon fractions from a heated mixture of said fractions in a liquid state which comprises: lowering the partial vapor pressure on a portion of said mixture by injecting steam therein; supplying heat to said portion from the remainder of said mixture, said remainder being held under its initial vapor tension; and removing the mixture of vapors produced by said injection and heating.

3. A process of separating a hydrocarbon fraction having definite boiling point limits from a mixture of hydrocarbon vapors which comprises: condensing from said vapors a condensate; passing a portion of said condensate at a temperature slightly below its initial boiling point at the pressure at which it is condensed into a space in which its partial pressure is sufficiently reduced to cause vaporization of light hydrocarbons therefrom; and supplying a portion of the heat necessary to produce said vaporization by conduction from the remainder of said condensate.

4. A process of separating a hydrocarbon fraction having definite boiling point limits from a mixture of hydrocarbon vapors which comprises: condensing from said vapors a condensate; passing a portion of said condensate at a temperature slightly below its initial boiling point at the pressure at which it is condensed into a space in which its partial pressure is sufficiently reduced by the introduction of steam to cause vaporization of light hydrocarbons therefrom; and supplying a portion of the heat necessary to produce said vaporization by conduction from the remainder of said condensate.

5. A process of separating a hydrocarbon fraction having definite boiling point limits from a mixture of hydrocarbon vapors which comprises; condensing from said vapors a condensate; passing a portion of said condensate at a temperature slightly below its initial boiling point at the pressure at which it is condensed into a space in which its partial pressure is sufficiently reduced to cause vaporization of light hydrocarbons therefrom; supplying a portion of the heat necessary to produce said vaporization by conduction from the remainder of said condensate; and passing said remainder back into direct contact with said vapors.

6. A process of separating a hydrocarbon fraction having definite boiling point limits from a mixture of hydrocarbon vapors which comprises: condensing from said vapors a condensate; passing a portion of said condensate at a temperature slightly below its initial boiling point at the pressure at which it is condensed into a space in which its partial pressure is sufficiently reduced to cause vaporization of light hydrocarbons therefrom; supplying a portion of the heat necessary to produce said vaporization by conduction from the remainder of said condensate; cooling said remainder; and passing said remainder back into direct contact with said vapors.

In testimony whereof, I have hereunto set my hand at San Francisco, California, this 16th day of August, 1923.

DANIEL PYZEL.

1,638,735

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Aug. 9, 1927.

L. C. HUFF

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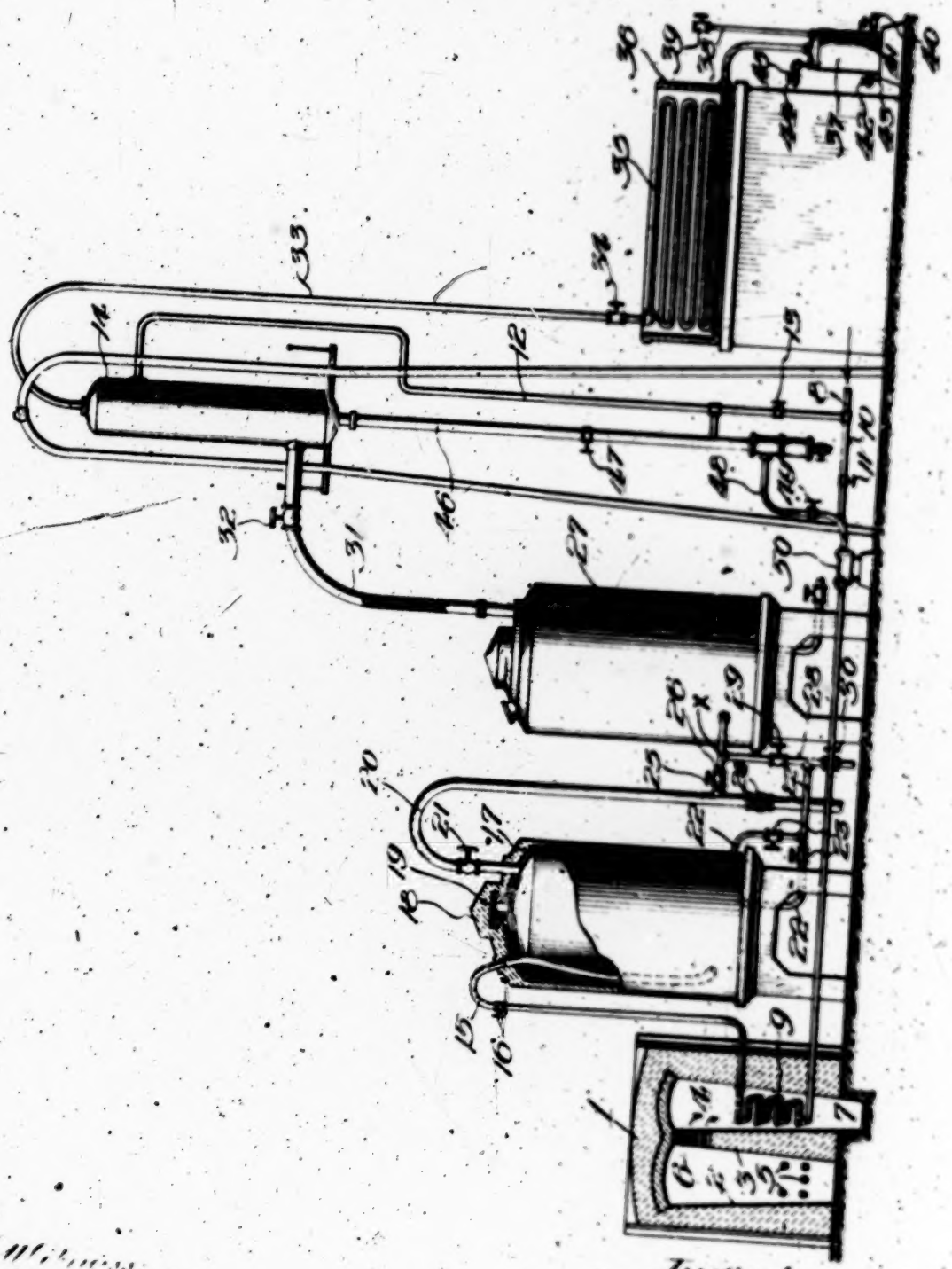
METHOD OF HYDROCARBON OIL CONVERSION

Filed Nov. 18, 1925



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Patented Aug. 9, 1927.

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1,638,735

UNITED STATES PATENT OFFICE.

LYMAN C. HUFF, OF CHICAGO, ILLINOIS, ASSIGNOR TO UNIVERSAL OIL PRODUCTS COMPANY, OF CHICAGO, ILLINOIS, A CORPORATION OF SOUTH DAKOTA.

METHOD OF HYDROCARBON OIL CONVERSION.

Application filed November 18, 1926. Serial No. 69,736.

This invention relates to improvements in method of hydro-carbon oil conversion, and refers more particularly to the subjection of hydro-carbon oil of low Baumé gravity to convert same into a range of products which have a higher gravity and which have a wider commercial market, such, for instance, as gasoline, kerosene and the like.

The specific embodiment of the present invention resides in heating the oil to a conversion temperature to cause substantial vaporization; in separating the vaporized portions from the unvaporized portion, and separately withdrawing same; in then mixing together the unvaporized and vaporized portions previously separated, and passing the combined mixture to a bulk supply where the vaporizable portions still existent in the heated bulk supply will separate and may be dephlegmated and condensed, in the usual manner.

As a feature of the invention, a predetermined pressure is maintained on the oil and vapors during the heating period and also during the period when the first separation of vapors from non-vaporizable residue takes place. The pressure may be then reduced, and by proper regulation in the second separating stage will result in the production of a residue controlled as to its viscosity and consistency and having a range from a substantially liquid residue containing suspended coke-forming particles down to a substantially solid residue consisting of a coke-like mass having substantially no liquid residue therein.

Other features and advantages of the process and apparatus will be apparent from the following description.

The single figure of the drawing is a diagrammatic side elevational view, partly in vertical section, of apparatus for carrying out the invention.

Referring more particularly to the drawing, 1 designates a side fired furnace of a standard type of commercial installation now on the market, provided with the combustion chamber 2, baffle 3 and tube chamber 4. The burners 5 generate gases of combustion within the chamber 2, passing through the flues 6 in a downward direction through the tube chamber 4, being exhausted at the point 7 to a suitable stack. The raw oil may be fed from any suitable source into the pipe 8, and said raw oil may be passed directly to the heating coil 9 through the pipe 10 by opening the valve 11, or it may be diverted and either all or a portion of the raw oil charge fed through the line 12, controlled by valve 13, into the upper end of the dephlegmator 14. This dephlegmator 14 may be of any standard form suitable for installations of this character and need not be described in detail. The raw oil charge is heated in the continuous heating coil 9 to conversion temperature and is transferred, by means of the transfer line 15 controlled by valve 16, to an enlarged expansion chamber 17. This expansion chamber 17 is preferably unheated and is, therefore, covered with any suitable form of lagging or insulation designated 18. The chamber may be provided with the usual upper and lower manhole plates 19 to facilitate cleaning.

The heated oil being introduced to said chamber through the transfer line 15 separates into vapors and a heated unvaporized residue. The vapors may be withdrawn through the vapor line 20 controlled by valve 21, while the unvaporized residue may be discharged through the residue draw-off line 22 controlled by valves 23. An auxiliary valve 24 in the vapor line 20 is closed, and a valve 25 in the line 26 is opened. The line 26 communicates with an enlarged chamber 27, which may be similar to the enlarged chamber 17 in design. The liquid residue draw-off pipes 22 communicate with a pipe 28 controlled by valve 29, which pipe 28 communicates in turn with the vapor communicating pipe 26. The valve 30 in the pipe 28 may be closed.

It is obvious, from the foregoing description, that the vapors separated in the chamber 17 have been remixed with the unvaporized portion withdrawn from the chamber 17, and this mixture passed to the chamber 27, where a further separation takes place. The purposes and advantages of this will be subsequently described.

The vapors released from the highly heated hydrocarbon mixture in the chamber 27 are passed through the vapor outlet pipe 31 controlled by throttle valve 32, discharging into the lower portion of the dephlegmator 14. In the dephlegmator 14, the vapors are subjected to suitable cooling mediums, and their upward travel is retarded in the usual way. The vapors which remain uncondensed after passing through the dephleg-

mator pass out through the vapor outlet pipe 33, in which is interposed throttle valve 34, discharging into the condensing coil 35 seated in condensing box 36, and the condensed product is cooled in the receiver 37 which is provided with the gas relief pipe 38, controlled by valve 39, and with the liquid draw-off pipe 40, controlled by valve 41. The receiver 37 is preferably provided with the usual sight gauges, pressure gauges and the like. In case it should be desirable to return a certain portion of the condensed distillate from the receiver 37 to the dephlegmator for cooling purposes, or to any part of the system, the valve 41 may be partially closed and the valve 42 in pipe 43 is opened, said pipe 43 being connected to the system. It may also be desirable to divert and return a portion of the incondensable gas, which may be accomplished by manipulating the valve 44 in the line 45.

The reflux condensate from the dephlegmator 14 may be withdrawn from the reflux leg 46, in which is interposed valve 47, to the line 18, controlled by throttle valve 49. A pump 50 is interposed in the line 48 for the purpose of mechanically imposing a higher pressure on the reflux condensate in order to overcome the loss of pressure due to friction and the intended reduction in pressure in the second chamber.

The operation of the apparatus hereinbefore described may be varied within relatively wide limits. The apparatus is extremely flexible and, as one illustration, the following process may be carried out:

The charging stock, withdrawn from any suitable storage, may be forced into the line 8 and may be heated in the heating coil 9 to a conversion temperature; for instance, the transfer temperature may be, say, from 700 to 950° F. more or less. The lighter fractions of the heated oil being discharged into the chamber 17 will vaporize, said vapors being withdrawn through the vapor outlet pipe 20. The unvaporized residue is withdrawn through the pipes 22, and the vapors and residue mixed together again at the point X, this mixture then discharging into the chamber 27. A pressure of from three pounds above atmospheric to several hundred pounds may be maintained on the oil being heated and on the heated hydro-carbon constituents in the chamber 17, but it is preferable to maintain this pressure above, say, 35 pounds. Through proper manipulation of the valves 29 and 25, the pressure on the mixture being introduced to the chamber 27 may be materially reduced; for instance, the chamber 17 may be maintained under a pressure of, say, 200 pounds to the square inch more or less, which pressure may be reduced to, say 100 pounds to the square inch in the chamber 27. It is a well known principle in the treatment of hydro-carbon oils that the reduction of pressure maintained on a body of heated hydro-carbon oil will cause vaporization of a portion of the volatile fractions existent in said hydro-carbon oil body due to the latent heat of said body and the reduction of pressure. This is one of the principles which is utilized in the present invention, in combination with other novel features.

It will be immediately apparent that by the proper regulation of the temperature at which the oil is originally heated and the extent of pressure reduction in the second chamber, the vaporization may be controlled to a nicety. Thus it will also be apparent that it is possible to control the viscosity or quality of the unvaporized residue remaining in the chamber 27 after the desired proportion of vapors have been relieved. By controlling the temperatures and pressures, the residue in the chamber 27 may range in viscosity and consistency from a substantially liquid unvaporized residue, containing precipitated carbon particles, to a substantially solid, coke-like residue, containing a minimum of liquid residue. Of course, it is to be understood that a liquid level is maintained within the second chamber and also that the second chamber is preferably externally unheated.

The present invention has been perfected to supply the need of refineries which wish to have a plant which is flexible enough to produce either a maximum yield of light gravity commercial products, such as gasoline and the like, with a minimum production of liquid residue, at low fuel costs, as well as a plant in which it is possible to produce an average yield of lighter gravity commercial products and at the same time produce a liquid residue which can be utilized for fuel. The mixing of the heated vapors and unvaporized heated residue from the first chamber and injecting the mixture into the second chamber at a lower pressure will have a beneficial effect on the liquid residue which is withdrawn from the second chamber, making it more stable and less liable to precipitate carbon particles when subsequently used, for instance, as a fuel oil. It is obvious, of course, that if the head of reflux condensate is high enough to overcome the reduction of pressure, the pump 50 may be dispensed with. The second chamber 27 may take the form, as desired, of an optional coking chamber, or an ordinary expansion chamber. I have shown two chambers 17 and 27 connected in series. It is obvious, of course, that any number, or any style, of chambers may be utilized without departing from the spirit of the present invention and, further, that external heating may be applied, if found desirable.

I claim as my invention:

1. A process for cracking hydrocarbon

oil, consisting in raising the oil to a cracking temperature while flowing in a restricted stream through a heating coil positioned in a furnace, in collecting a body of the heated oil, subsequent to its passage through the heating coil, in an enlarged reaction zone, wherein conversion occurs, in separately removing the vapors evolved from the oil and unvaporized liquid oil from said reaction zone, in admitting said vapors and unvaporized liquid oil to a zone maintained under a lower pressure than said reaction zone, whercin substantial quantities of the unvaporized liquid oil is vaporized by the contained heat thereof, in removing the unvaporized oil from said zone maintained under said lower pressure without again returning the same to said zone, in subjecting the vapors evolved from the oil in said reaction zone and the vapors evolved from the unvaporized liquid oil in said zone of reduced pressure, in a commingled state, to reflux condensation, in aiding in the reflux condensation of the vapors by employing charging oil for the process as a cooling medium therefor and to also preheat the charging oil, in collecting a supply of commingled reflux condensate separated from the vapors and preheated charging oil in a zone out of contact with unvaporized liquid oil introduced to said zone of reduced pressure, and in continuously admitting oil from said supply to said heating coil.

2. A process for cracking hydrocarbon oil, consisting in maintaining a body of oil under cracking conditions of temperature and pressure in an enlarged zone, in removing vapors evolved from the oil from such enlarged zone, in separately removing the heated unvaporized liquid oil from said enlarged zone, in introducing the vapors and the unvaporized liquid oil removed from said enlarged zone to a zone maintained under a lower pressure than said enlarged zone, wherein a vaporization of substantial quantities of such unvaporized liquid oil is effected by the contained heat thereof, in removing the unvaporized oil from said zone maintained under said lower pressure without again returning the same to said zone, in subjecting all the vapors evolved from the oil in both of said zones to a reflux condensing action, in utilizing charging oil for the process as the cooling medium, to aid in the reflux condensation of the vapors, in collecting a substantial supply of the reflux condensate separated from the vapors and charging oil which has been employed as a cooling medium for the vapors undergoing reflux condensation in a zone apart from said zone of reduced pressure, whereby said reflux condensate and charging oil is prevented from commingling with the unvaporized liquid oil introduced to said zone of reduced pressure and in continuously forcing a stream of commingled charging oil and reflux condensate from said supply through a heating coil, wherein the same is raised to a cracking temperature, and in thereafter admitting said heated stream of oil to said body of oil maintained in said enlarged zone.

3. A process for cracking hydrocarbon oil, consisting in raising the oil to a cracking temperature while flowing in a stream through a heating coil, in delivering the heated oil, subsequent to its passage through the heating coil, to an enlarged reaction zone, in separately removing vapors evolved from the oil and unvaporized liquid oil from said reaction zone, in materially reducing the pressure on the unvaporized liquid oil removed from said reaction zone, to cause substantial quantities of such oil to vaporize by latent heat thereof, isolating the oil unvaporized by said reduction in pressure from the process, in subjecting the vapors released from such unvaporized oil, together with vapors removed from said enlarged reaction zone, while in a commingled state, to reflux condensation, in continuously passing the reflux condensate separated from such commingled vapors undergoing reflux condensation, together with incoming charging oil for the process, through said heating coil.

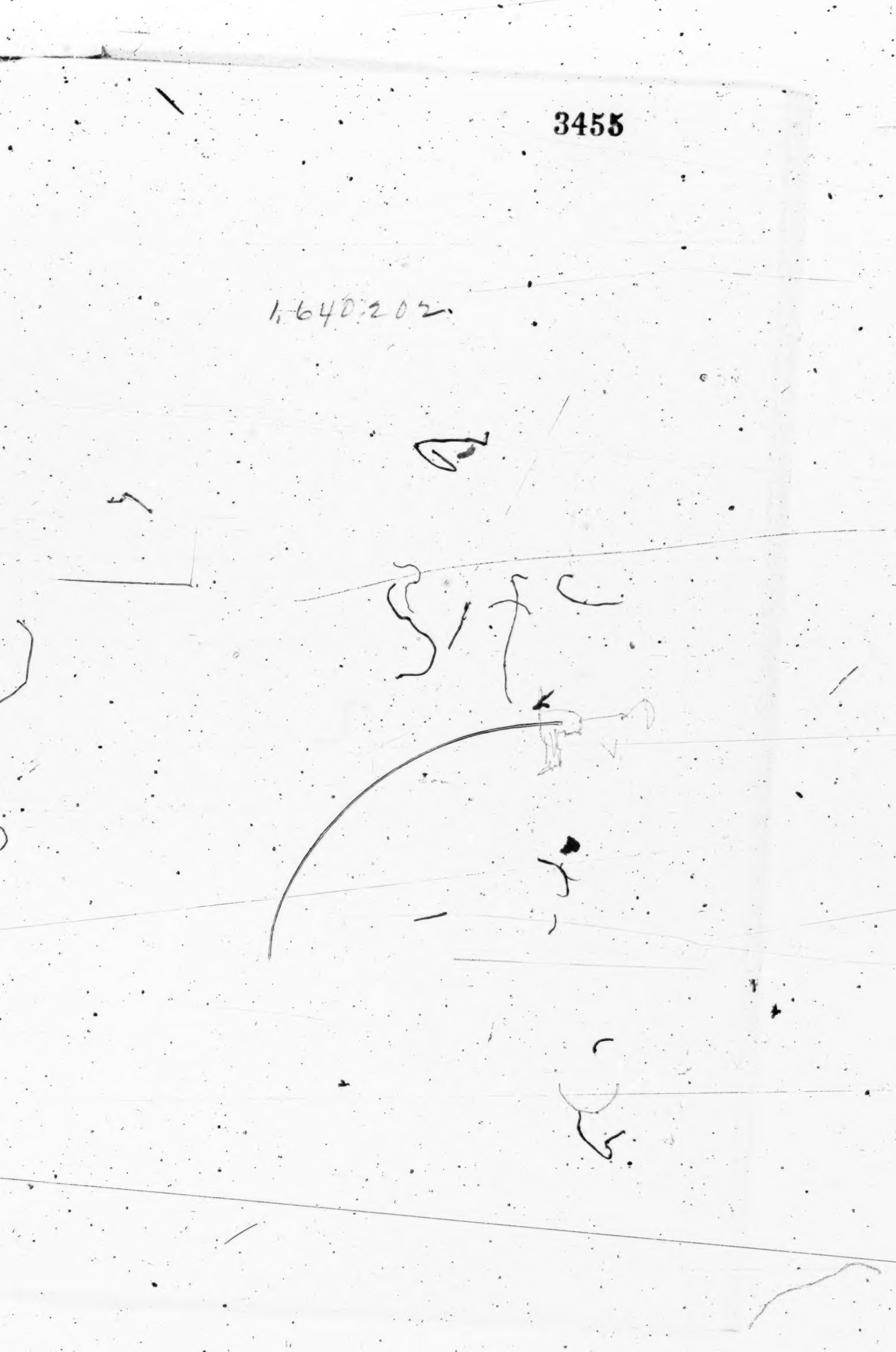
4. A continuous process for cracking hydrocarbon oil, comprising raising the oil to a cracking temperature while flowing in a restricted stream through a heating coil positioned in a furnace, delivering the heated oil from said coil to an enlarged reaction zone, wherein conversion occurs, maintaining a superatmospheric pressure on the oil in said coil and reaction zone, separately removing vapors evolved from the oil and unvaporized liquid oil from said reaction zone, releasing the pressure on the unvaporized liquid oil removed from said reaction zone, to effect further vaporization thereof by latent heat of said unvaporized liquid oil, isolating that portion of the heavy unvaporized oil which does not vaporize under the reduced pressure from the process, subjecting the vapors evolved from the unvaporized oil, due to such release of pressure, together with vapors removed from said reaction zone, while in a commingled state, to reflux condensation, under a pressure not in excess of the pressure maintained on the unvaporized liquid oil subsequent to its removal from said reaction zone, uniting charging oil for the process with reflux condensate separated from said commingled vapors undergoing reflux condensation, and supplying the resulting mixture to said heating coil.

5. A continuous process for cracking hydrocarbon oil, comprising raising the oil to a cracking temperature while flowing through a heating coil disposed within a furnace,

delivering the heated oil, subsequent to its passage through the heating coil, to an enlarged reaction chamber, maintaining a superatmospheric pressure on the oil in the coil and reaction chamber, separately removing vapors and unvaporized liquid oil from the reaction chamber, delivering such removed vapors and unvaporized liquid oil to a common zone maintained under a substantially lower pressure than is maintained in said reaction chamber, and wherein substantial quantities of the unvaporized liquid oil removed from said reaction chamber are vaporized by the latent heat of such unvaporized liquid oil, subjecting the vapors removed from said reaction chamber, together with vapors released from said unvaporized liquid oil in said common zone, to reflux condensation, under a pressure not in excess of the pressure maintained in said common zone, removing the unvaporized residue from said common zone without again admitting the same to the oil undergoing treatment in the process, and supplying the reflux condensate separated from said commingled vapors, together with charging oil, to said heating coil.

LYMAN C. HUFF.

1,640,202.



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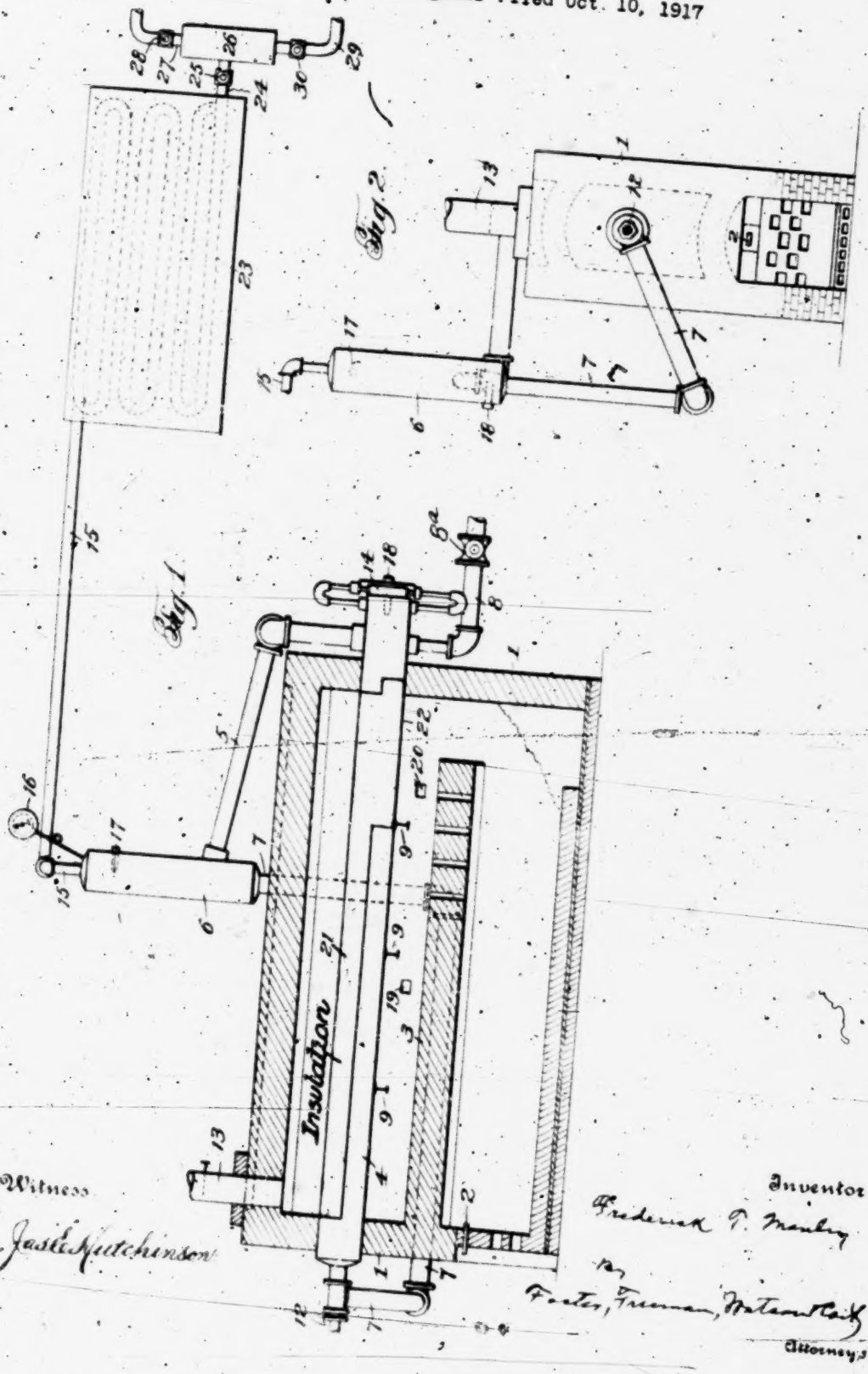
Aug. 23, 1927.

F. T. MANLEY 1,640,202

APPARATUS FOR THE DISTILLATION OF OIL

Original Filed Oct. 10, 1917



Witness
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Frederick T. Manley
By
Foster, Freeman, Watson & Coit
Attorneys

Patented Aug. 23, 1927.

3457 1,640,202

UNITED STATES PATENT OFFICE.

FREDERICK T. MANLEY, OF HOUSTON, TEXAS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE.

APPARATUS FOR THE DISTILLATION OF OIL.

Original application filed October 10, 1917, Serial No. 195,777. Divided and this application filed October 26, 1918. Serial No. 259,839.

My invention relates to a new and improved still for distilling mineral oils. It is particularly adapted for the decomposition of higher-boiling hydrocarbons into lower-boiling hydrocarbons by means of a distillation under pressure carried on in a combined liquid-vapor phase.

This application is a division of application Ser. No. 195,777, filed October 10, 1917, which matured into Patent No. 1,428,339 on September 5, 1922.

In the prior art, stills have been used which were heated only on their lower portions or along that part of the still which was covered with liquid oil, the upper part or the vapor portion being relatively cool. Stills have also been used which were heated entirely around their periphery. In stills of this type there is great danger of the vapor zone being overheated because vapor is a relatively poorer conductor of heat than liquid. My invention contemplates a still having both its liquid and vapor portions heated under such circumstances that there is substantially the same temperature in the vapor zone as in the liquid zone.

Whenever oil is heated under pressure for the purpose of carrying on its decomposition there is always a large amount of vapor generated merely through vaporization and composed of undecomposed hydrocarbons. In my improved still I have provided a novel cycle arrangement by which this vapor is allowed to go out through the vapor line at one end of the still, but is separated out and returned to the opposite end of the still, a circulation being thus carried on so that the decomposed hydrocarbons may be removed from the still and whereby the undecomposed constituents are continuously circulated through the cracking zone. The vapors are kept in constant circulation within the still and are thus prevented from being overheated and causing the formation of an excess of carbon and unsaturated hydrocarbons.

The drawing illustrates the preferred form of the invention:

Figure 1 is a longitudinal section, parts being shown in plan;

Figure 2 is an end view.

Referring to the drawings the still 4 is situated in the furnace 1, which has the burner 2, the baffle wall 3, and the stack 13. The still is preferably constructed of considerable length in comparison with its diameter. It is supported by the walls of the furnace and T irons 9. At one end of the still is the vapor line 5 terminating in the separator or air condenser 6. The condensate pipe 7 extends from the air condenser to the other end of the still 4. A pipe 12 for charging the oil enters the still at any convenient point, preferably at or near the point at which the condensate pipe 7 enters the same. The valve 8ª in draw-off pipe 8 is provided for withdrawing the residue from the still. The upper periphery of the still is equipped with a heat insulating medium 21, which may be constructed of any suitable refractory material. It is designed to cover the vapor portion of the still.

Extending from the air condenser 6 is the vapor line 15 terminating in the condenser coil 23, having the outlet 24, which is equipped with the valve 25. This condenser outlet opens into the receiving drum 26, which has the gas outlet 27 fitted with the valve 28 and the condensate outlet 29 equipped with the valve 30. It is advisable to equip the still with certain accessories which I have illustrated, as the recording thermometers 17 and 18, the liquid level indicator 14, the furnace pyrometers 19 and 20, and the pressure gauge 16.

In the type of furnace illustrated, the heat arrangements are such that the heat of combustion is deflected by the baffle 3 to the rear of the furnace where it enters the chamber containing the still 4 and passes along the still imparting an even heat to the periphery thereof. It may be desirable to provide a suitable insulation 22 along that portion of the still against which the furnace gases first strike.

My apparatus is designed for carrying on an intermittent or a continuous distillation. It is particularly adapted for the continuous conversion of higher-boiling hydrocarbons into lower-boiling hydrocarbons, such as the decomposition of kerosene, gas oil, and the like into such volatile products as gasoline and naphtha. The oil to be converted is continuously forced into the still through the charging line 12. The vapors and gases generated gather in the upper portions of the still and pass out through the vapor line 5. The residue formed is

drawn off by means of the outlet 8. The air condenser 6 is maintained at such temperature that the products of desired volatility remain in the vapor state therein while the heavier products are condensed and are returned to the still through the condensate line 7. The vapors and gases accumulating in the condenser 6 pass out through the vapor line 15 into the condenser 23 where the vapors are condensed. The condensate is collected in the drum 26 and may be withdrawn through the outlet 29. The permanent gases escape through the outlet 27. Pressure may be easily controlled in the apparatus by means of either the valve 25 or 28. If desired a valve for controlling the pressure may be placed in the line 15; however, the best control is secured by using either the valve 25 or 28. The condensed products accumulating in the air condenser 6 are continuously returned to the still through the condensate line 7, thus forming a continuous cycle whereby the unconverted constituents are continuously repassed through the cracking zone. The constituents returning from the air condenser are forced to travel the length of the still before they can escape into any vapor line; they are thus subjected to the cracking temperature for a sufficient time for a conversion of the greater portion into hydrocarbons of the desired volatility. The continued cycle through the cracking zone insures the ultimate decomposition of all the unconverted vapors. Without the insulation 21 the vapor portion of the still would attain a temperature considerably higher than the liquid portion causing the vapors to be overheated, and resulting in the formation of a product containing a large proportion of unsaturated compounds. By means of this insulation the conduction of heat into the vapor zone is reduced so that both the liquid and vapor portions are maintained at substantially the same temperature, or at least with only a slightly higher temperature in the vapor zone, thereby creating an even temperatured cracking zone. By means of the continual movement of the vapors maintained by the cycle arrangement and with the insulated vapor zone, the decomposition is effected with a minimum production of fixed gas and carbon. The product which is collected as a condensate in the drum 26 is, for a cracked product, remarkably sweet, in other words, low in unsaturated compounds.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. In an apparatus for converting hydrocarbon oils, a furnace of refractory material, a still disposed therein and adapted to be partially filled with liquid oil, means for circulating the heat of combustion around substantially the entire external periphery of said still to apply cracking heat to both the vapor and liquid portions thereof and a heat insulating medium on the vapor portion of said still above the liquid level to prevent the oil vapor therein from being heated to a temperature materially higher than the liquid oil in the liquid portion and to provide a cracking zone of substantially uniform cracking temperature.

2. In an apparatus for converting hydrocarbon oils, a still adapted to be partially filled with liquid oil, means for applying cracking heat to substantially the entire external periphery of the liquid and vapor portions thereof, a heat-insulating medium disposed around the vapor portion to prevent the oil vapor therein from being heated to a temperature materially above that of the liquid in the liquid portion and means for creating a circulation of oil through the cracking zone of the still comprising a separator, a vapor outlet extending from one end of the still to said separator and a condensate line extending from said separator to the other end of the still.

3. In apparatus for converting hydrocarbon oils, a still adapted to be partially filled with liquid oil, means for applying cracking heat to substantially the entire external periphery of the liquid and vapor portions thereof, a heat insulating medium disposed around the vapor portion to prevent the oil vapor therein from being heated to a temperature materially above that of the liquid in the liquid portion, means for creating a circulation of oil through the cracking zone of the still comprising a separator, a vapor outlet extending from one end of the still to said separator and a condensate line extending from said separator to the other end of the still, means for removing from the separator the uncondensed constituents therein and condensing the condensable portions thereof and means for regulating the pressure in the apparatus.

4. In an apparatus for converting hydrocarbon oil, a still adapted to be partially filled with hydrocarbon oil during operation with a vapor space above said oil, and means for circulating a heating medium around substantially the entire external periphery of said still to bring its walls and the contained material to cracking temperatures, that portion of the walls of the still above the normal oil level being made less conductive of heat than the portion in contact with the oil to provide a cracking zone of a substantially uniform temperature.

5. In an apparatus for converting hydrocarbon oils, a still adapted to contain a body of liquid oil to be converted and having a vapor space above the level of the oil therein, and heating means constructed and arranged to supply external heat around sub-

stantially the entire periphery of both the liquid and vapor portions of the still and including a heat-insulating medium disposed upon the vapor portion thereof to maintain the oil and the vapors therein at a substantially uniform cracking temperature whereby conversion takes place in the still without overheating the vapors.

6. In an apparatus for converting hydrocarbon oil, a still adapted to contain a body of oil to be converted and having a vapor space above the level of the oil therein, means constructed and arranged to supply external heat around substantially the entire periphery of both the upper and lower portions of the still to raise the contents to cracking temperatures, means associated with the vapor portion to materially reduce the rate of heat in-put to the vapors to maintain the oil and the vapors at a substantially uniform cracking temperature whereby conversion takes place without overheating the vapors, and means for creating a cyclic circulation of oil through the cracking zone of the still to cause the unconverted constituents of the vapor to be repassed through the still whereby they are repeatedly subjected to cracking conditions.

7. In an apparatus for converting hydrocarbon oil, a still adapted to contain a body of oil to be converted and having a vapor space above the level of the oil therein, and means constructed and arranged to supply external heat around the periphery of both the upper and lower portions of the still to heat the oil to a cracking temperature, and means for preventing overheating the evolved vapors and the formation of excess carbon and unsaturated hydrocarbons, said means comprising heat insulating means associated with the upper portion of the still adjacent the vapor space and means for effecting a cyclic circulation of the unconverted constituents of the vapors through the cracking zone.

8. In an apparatus for converting hydrocarbon oils, an elongated horizontally disposed still of heat conductive material adapted to contain a body of oil and having a vapor space above the level of the oil therein, means for supplying oil to said still, a furnace for heating said still to a cracking temperature constructed and arranged to envelope said still and to pass the heat of combustion along the periphery of said still from one end to the other, means for heat insulating the upper portion of the still adjacent the vapor space to prevent overheating thereof and maintain the vapors in the vapor space at substantially the same cracking temperature as the oil whereby conversion takes place in said still, and means for removing the evolved vapors therefrom.

9. In an apparatus for converting hydrocarbon oil, a horizontal elongated still adapted to be partially filled with liquid oil and having a vapor space above the oil level, a furnace enveloping substantially the whole of said still and constructed to cause the products of combustion to pass longitudinally along the still from one end to the other while surrounding substantially the entire external periphery of both the vapor and the liquid portions thereof, and a heat insulating covering over the upper vapor portion of the still from end to end to prevent the vapors in the vapor portion being raised to a materially higher temperature than the oil in the liquid portion thereof.

In testimony whereof I affix my signature.

FREDERICK T. MANLEY.

1,655,603

3462

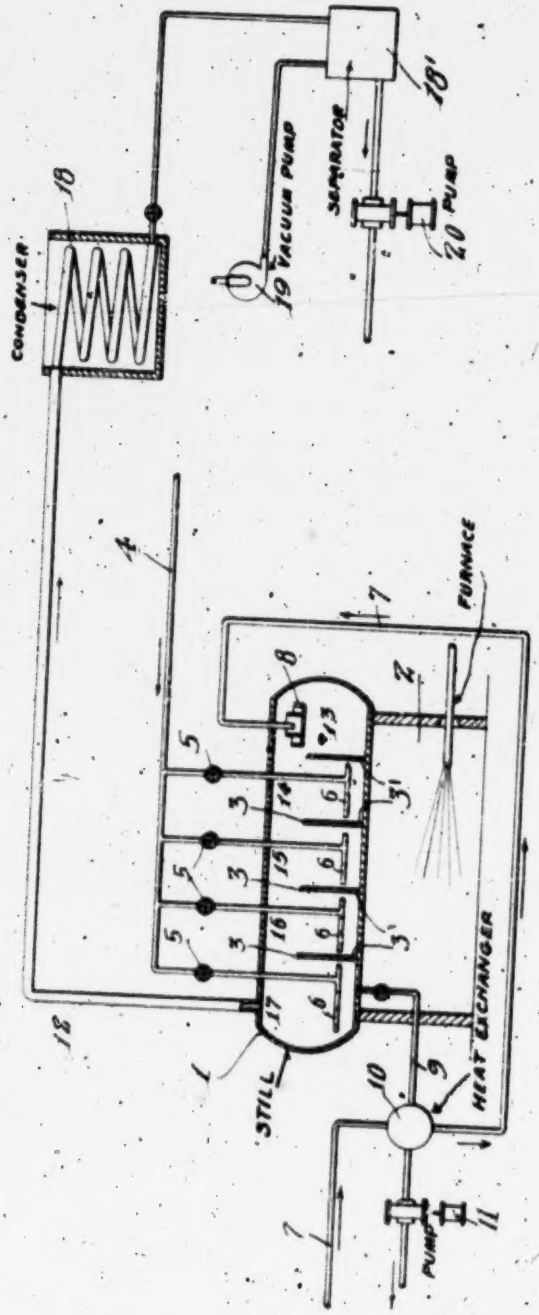
Jan. 10, 1928.

R. W. HANNA

1,655,603

PROCESS OF DISTILLING PETROLEUM OIL

Filed March 31, 1923



Inventor
Richard W Hanna
By Lyon & Lyon, Attys

Patented Jan. 10, 1928. 1,655,603

3463

UNITED STATES PATENT OFFICE.

RICHARD WRIGHT HANNA, OF PIEDMONT, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO STANDARD OIL COMPANY OF CALIFORNIA, OF SAN FRANCISCO, CALIFORNIA, A CORPORATION OF DELAWARE.

PROCESS OF DISTILLING PETROLEUM OIL.

Application filed March 31, 1923. Serial No. 629,053.

This invention relates to the distillation of petroleum oils and in particular to the distillation of those high boiling point fractions of pertoleum, desirable as distillates and whose boiling temperatures are so high as to make their distillation without accompanying destructive distillation, or cracking, impractical by ordinary means.

The fact that many petroleum oils have boiling temperatures higher than the temperatures at which some portions of these same oils break down or crack, has long been a source of trouble to refiners. Because of this fact the yield of desirable heavy distillates has been reduced and additional rerunning of distillates made necessary.

The breaking down by cracking of a part of the oil, not only reduces the yield of the most desirable high boiling point distillates, such as cylinder stock, but a part of the heavier of the cracked fractions commingle with the natural distillates and change to a certain extent the characteristics of the recovered distillates.

The detrimental effects of cracking are made particularly evident in the production of high grade lubricating oils, where, because of the high temperatures required for their distillation, cracking is most apparent and from which distillates the lighter cracked products must be removed by rerunning.

In attempting to prevent cracking by the reduction of still temperatures open steam is almost universally used during the distillation of the heavier products. The partial pressure effect of the steam is to permit a continual vaporization of the oil at a temperature below its boiling point at the pressure employed. Resort has also been made to distillation in partial vacuum, both with and without steam. In all cases, however, the final and highest boiling point fractions have been removed from the reduced residuum in the absence of the vapors of the lighter fractions, these having been distilled off. That is, fractional distillation is the universal practice, whether the process is continuous or batch, and whether or not distillation is carried on in a single still or a number of stills operating in series.

In the customary processes of distilling petroleum oil from its residuum, the different boiling point oils are removed in the order of their vaporizing temperature. Accordingly, the highest boiling oils are left in the residuum to be separately distilled therefrom. Such highest boiling petroleum oils are generally the most readily decomposed or cracked oils obtained from the crude.

If, in place of separately vaporizing the higher boiling point oils, the higher boiling point oils are vaporized simultaneously with the vaporization of a more readily vaporized oil, the temperature at which the higher boiling point oils can be vaporized is materially reduced. The reduction of the vaporizing temperature of the higher boiling point oils is due to the influence of the lower boiling point oils. The vapors of the lower boiling point oils being commingled with those of the higher boiling point oils assist the vaporization of such higher boiling point oils by their partial pressure effect on the oil undergoing treatment.

When the distillation of petroleum oil is conducted continuously, and at greatly reduced pressure and preferably with the use of steam, and the highest boiling point oils vaporized from the residuum simultaneously with the vaporization of a material quantity of substantially lower boiling point oils, the temperature at which the highest boiling point oils may be vaporized is so reduced that decomposition of such high boiling oils is substantially prevented.

The objects and advantages of this invention will be more readily understood from a description of an apparatus and a process embodying the invention as practiced in such an apparatus, it being understood that such apparatus and process so hereinafter described is given only as an example of a practical embodiment of the invention.

In the drawings, 1 represents a still set over a furnace 2. Preferably the still is provided with baffles 3, with small openings 3′ at the bottom, which extend across the still 1, which baffles separate the still into a plurality of semi-separate compartments indicated at 13, 14, 15, 16 and 17 respectively. 7 indicates the feed line to the still which preferably passes through a tar heat exchanger 10, communicates with the still at one of end compartments 13, and discharges the feed oil into a drip pan 8 therein. The still

is provided with a residuum drawoff line 9 which preferably communicates with the end compartment 17, which compartment is at the opposite end of a still 1 to which the feed line 7 communicates. Said line 9 preferably leads through the heat exchanger 10, hence through a pump 11 to storage. 12 indicates the vapor line of the still which preferably communicates with the end compartment 17. Said vapor line 12 leads through a condenser 18 to a separator 18' to which vacuum pump 19 is connected. From the separator 18' by means of the pump 20 the condensate may be transferred as desired to suitable storage, etc. 4 indicates a steam line leading from a source of steam (not shown) and connected through valves 5 to spray lines 6 in the various compartments of the still.

When vaporizing the highest boiling point and most readily decomposed or cracked oils, the oil, as fed into the still through the line 7, comprises not only the highest boiling point and most readily decomposed or cracked oil, but the feed oil includes also a substantial quantity of materially lower boiling point oils, which oils act to influence and assist the vaporization of such high boiling point and readily decomposed oil from the residuum. The vaporization within the still of any oil of lower boiling point than such high boiling point oil will reduce the vaporizing temperature of such high boiling point oil. Thus, for carrying forth the invention so as to utilize the maximum advantage of the influence of low boiling point petroleum vapors, all the vapors of a crude oil should be evolved simultaneously with the relatively higher boiling point vapors. However, as later described, since the vaporization of the oil fed into the still is at greatly reduced pressure, as an aid to the vaporization of the readily decomposed oil, we prefer, because of the difficulty of condensing the lowest boiling point constituents at the reduced pressure, to first separately distill some of the lighter fractions from the crude.

For convenience the numerous constituents of petroleum may be classified as: motor fuels, lamp oils, gas oils, viscous or lubricating distillates, and the residuum. The motor fuels are the lighter or lower boiling point fractions of petroleum. The lamp oils are the next heavier or higher boiling point fractions. The gas oils are those fractions of petroleum obtained between the lamp oils and the lubricating distillates. The gas oils are generally too heavy to be employed as a burning fuel for lamps and not sufficiently viscous for use as lubricants. The viscous or lubricating distillates are the highest boiling point fractions normally distilled from the oil and are used as lubricating oils or as charging stocks for cracking processes. The residuum of the oil is the residue left after the separation of the other constituents named and will vary in character with the nature of the oil treated.

Even when operating at greatly reduced pressure and with the use of steam, some of the higher boiling point viscous or lubricating oils are decomposed when vaporizing the same from their residuum unless such vaporization is effected in the pressure of the vapors of lower boiling point oil. When separating certain oils from their residuum I prefer to include in the feed oil to the still substantially all the lubricating constituents with the residuum. How much lower boiling point oils should be distilled with the readily decomposed oil will depend on the apparatus available, and the amount and boiling temperature of the higher boiling point oils which are to be vaporized. With a familar grade of California oil the feed oil is normally reduced to a gravity between 14° and 17° Baumé before being fed into the still. Equivalent feed oil from other crudes may have a materially different gravity. In some cases, however, it is advisable to employ the additional influence of lower boiling point oils, such as the gas oil or even lower boiling point oils.

By operation of the pump 19, the pressure in the still 1 is maintained as low as practically possible, preferably a vacuum in excess of 24 inches of mercury or less than 2.9 pounds per square inch absolute pressure should be maintained. Preferably steam is used to assist the vaporization of the oils in the still 1 and the oils in the still are maintained at a temperature sufficiently low to prevent any substantial amount of cracking.

The distillation is maintained continuously, the feed oil being continuously fed to the still, the desired lubricating fractions being continuously and simultaneously withdrawn through the vapor line 12, and the residuum continuously withdrawn through the line 9 by operation of the pump 11. The distillation of the desired lubricating distillates in one operation or step is obtained by regulating the draw off of residuum so that the oil remains in the still the requisite period of time. The still should be maintained under as nearly constant conditions as possible, thus the temperature of the oil in the still, the quality and quantity of steam, the rate of fire, the degree of vacuum, the rate of feeding the oil and rate of residuum draw off—all should be gaged and maintained constant. By frequent inspection of the residuum draw off and of the distillate the operator may determie whether the desired reduction thereof and vaporization of the lubricating distillates are being accomplished.

The use of the baffles 3 in the still prevent convection currents in the liquid which

might otherwise cause incompletely reduced oil to pass out through the residuum draw-off line.

By vaporizing the lower boiling point lubricating distillates in the same still with the higher boiling point lubricating distillates the temperature at which the higher boiling point distillates may be distilled from the residuum is greatly decreased and decomposition is substantially prevented. If the commingled lubricating distillates thus separated from the residuum are to be used to form lubricating oils, the various grades of lubricating oils may be separated thereafter by fractional distillation, in which case, however, the highest boiling point oils, such as cylinder oil, are withdrawn as the residuum of the fractionating process without being again distilled.

A further advantage of the described process and of the resultant lubricating distillate resides in the value of the produced lubricating distillate as a charging stock for a cracking process. By substantially avoiding cracking in the separation of the lubricating distillate from the residuum or base of the oil, an oil is produced which has a maximum hydrogen content and especially suited for cracking, for the reasons clearly set forth in my Letters Patent No. 1,419,378, granted June 13, 1922.

This process is capable of numerous modifications, and is not, therefore, limited to the particular embodiment described for illustrating the invention, but is of the scope set forth in the accompanying claims.

I claim:

1. A continuous process of distilling petroleum oil to evolve heavy lubricating oil fractions therefrom having a decomposing temperature below their vaporizing temperature when heated under a substantial vacuum and substantially preventing decomposition of such heavy lubricating oil fractions, comprising feeding into a single distilling zone oil containing such heavy lubricating oil fractions and lighter lubricating oil fractions, maintaining the distilling zone at substantially a constant temperature below the decomposing temperature of said heavy fractions and under a reduced pressure to vaporize said heavy fractions in the pressure of the vapors of said lighter fractions, and continuously withdrawing said resulting mixed vapors and residue from the distilling zone in such relation of volume and speed as to cause the vaporization of both said heavy and light lubricating oil fractions.

2. A continuous process of distilling petroleum oil to evolve heavy lubricating oil fractions therefrom having a decomposing temperature below their vaporizing temperature when heated under a substantial vacuum and substantially preventing decomposition of such heavy lubricating oil fractions, comprising feeding into a single distilling zone oil containing such heavy lubricating oil fractions and lighter lubricating oil fractions, maintaining the distilling zone at substantially a constant temperature and below the decomposing temperature of said heavy fractions and under a reduced pressure assisted by the injection of steam to vaporize said heavy fractions in the pressure of the vapors of said lighter fractions, and continuously withdrawing said resulting mixed vapors and residue from the distilling zone in such relation of volume and speed as to cause the vaporization of both said heavy and light lubricating oil fractions.

3. A continuous process of distilling petroleum oil to evolve heavy lubricating oil fractions therefrom having a decomposing temperature below their vaporization temperature when heated under a substantial vacuum and substantially preventing decomposition of such heavy lubricating oil fractions, comprising feeding into a single distilling zone an oil containing the residuum and substantially all the viscous constituents originally present in the crude oil, including cylinder oil stocks and lower boiling point lubricating oil fractions, maintaining the distilling zone at a constant temperature below the decomposing temperature of the said heavy lubricating oil fractions comprising the cylinder oil stock and under a reduced pressure to vaporize said cylinder oil stock in the pressure of the vapors of said lighter lubricating oil fractions, continuously withdrawing the resulting mixed vapors and the residue from the distilling zone in such relation of volume and speed as to cause the vaporization of substantially all the lubricating oil fractions contained in said feed oil.

Signed at Richmond, Calif., this 21st day of March, 1923.

RICHARD WRIGHT HANNA.

3468

Oct. 9, 1928.

C. P. DUBBS

1,686,654

METHOD FOR TREATING HYDROCARBON OILS

Original Filed April 15, 1925 2 Sheets-Sheet 1

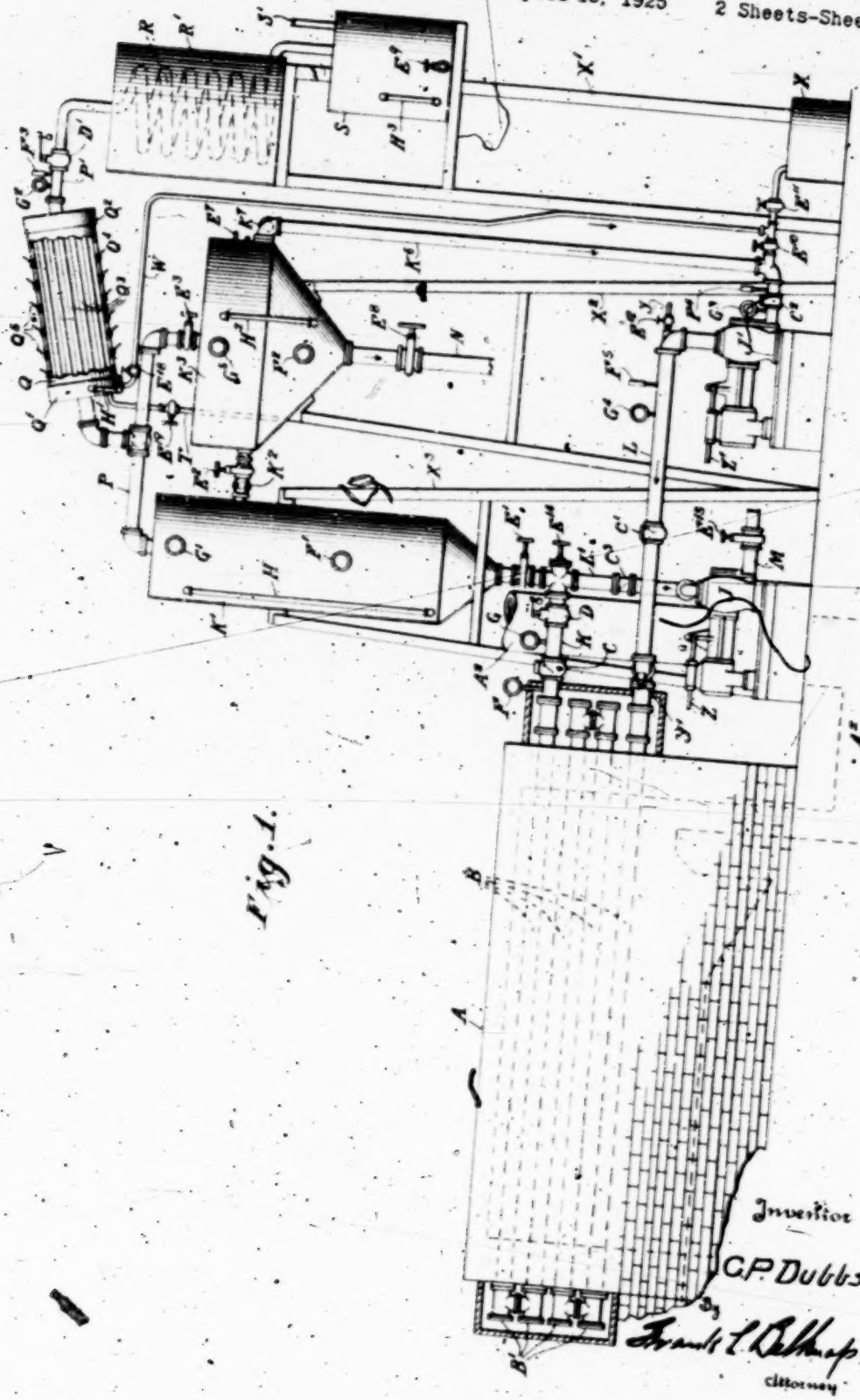


Fig. 1.

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3470

Oct. 9, 1928.

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METHOD FOR TREATING HYDROCARBON OILS

Original Filed April 15, 1925 2 Sheets-Sheet 2

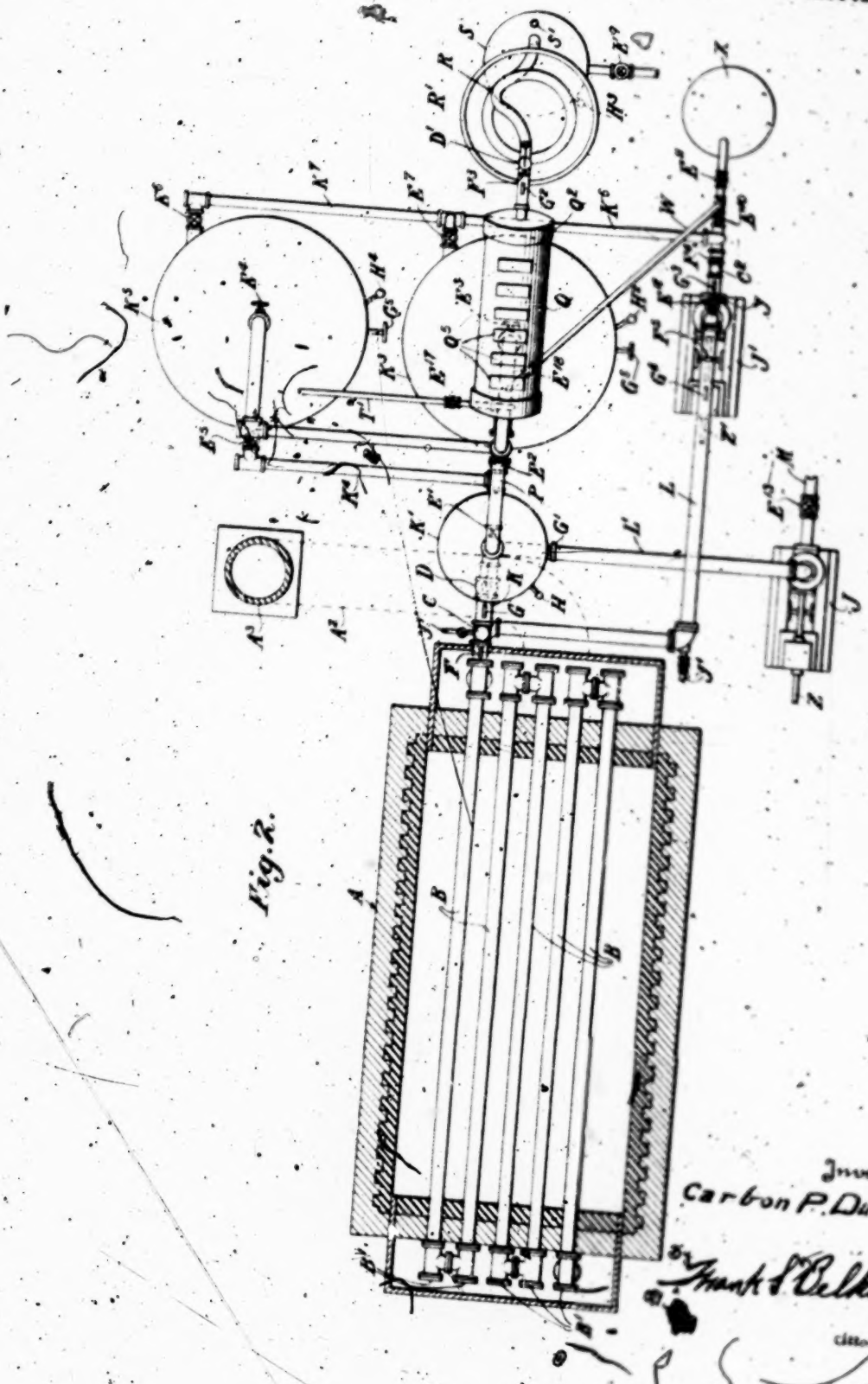

Fig. 2.

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Patented Oct. 9, 1928.

3471

1,686,654

UNITED STATES PATENT OFFICE.

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METHOD FOR TREATING HYDROCARBON OILS.

Original application filed April 15, 1925, Serial No. 23 389, which in turn is a division of Serial No. 595,743, filed October 20, 1922, the latter being a continuation of Serial No 208,206, filed December 21, 1917. Divided and this application filed August 18, 1926. Serial No. 200,519.

This invention relates to a method for treating hydrocarbon oils to produce therefrom products having lower boiling points, and is a division of my application Serial No. 23,389 filed April 15, 1925, which application is a division of my application Serial No. 595,743, filed October 20, 1922, the last named application being a continuation of my application Serial No. 208,206, filed December 21, 1917.

My invention contemplates, among other things, a method whereby crude petroleum, petroleum distillates, petroleum residuum, or mixtures thereof is passed through the apparatus and more or less converted to lower boiling point products; other objects of my invention are: to provide a process for heating oils in coils while maintaining the oil under definitely controlled velocity and temperature, then passing the heated oil to an upright tank and from there into a settling tank and then back through the same heating coils; to provide a process for continuously treating petroleum for production of lower boiling point products; to provide a process for automatically condensing the heavy vapors and returning same for fruther treatment; to provide a process whereby either water, in the shape of water or steam or both, can be injected into the oil while undergoing treatment; to provide a process whereby any water condensed in the reflux condenser is automatically trapped and either automatically returned to the heating coils or withdrawn from the system; to provide a process for holding a higher pressure upon the oil while same is circulated through the heating tubes and holding a lower pressure on the upright and settling tanks or oil receiving means and reflux condenser; to provide a process for rapid circulation of oil in heating coils and relatively slow circulation in the settling tank; to provide a means of continuously feeding raw material and continuously taking off lower boiling point products and also for continuously taking off the residuum containing more or less free carbon; to provide a process to prevent the free carbon or other solids from settling on the walls of the heating tubes; to provide a process whereby the forced circulation in a continuous coil creates a pressure on the oil in excess of that maintained on the rest of the apparatus whereby the oil in said coil can be subjected to a higher heat without being converted, to any great amount, into vapors, and said oil is passed into a chamber of lower pressure. The boiling point of said heated oil is thereby lowered and more or less of same thus converted into vapors; to provide a process whereby the oil while being heated is maintained at a relatively high velocity and then passed in a much larger stream through a settling tank and owing to this stream being much larger its velocity has been greatly reduced which will cause the excess carbon held in the oil to be precipitated out; to provide a process whereby the length of time the oil being treated is subjected to heat during any one time is under full control; to provide a process whereby the amount of heavy vapors condensed and returned for further treatment is controlled; to provide a process for maintaining the interior surface of the tubes in a smooth highly polished condition by a process of passing the oil through same at a high velocity; to provide a process for frequently relieving the oil in the heating tubes of its vapor contents; to provide a process for bringing part of the residuum to a quiescent state and allowing the free carbon or other solids to settle and withdrawing same and returning the settled residuum back into the circulation for further treatment; to provide, in general, a process and apparatus of the character referred to.

In the drawings,—

Figure 1 is a side elevation of the apparatus, partly in section and partly broken away;

Fig. 2 is a plan view of the apparatus, with parts in section.

Referring to the drawings, A is the furnace in which the heating tubes B are positioned. A^2 is a flue tunnel connecting said furnace to stack marked A^4. B^1 are return connections on the ends of the tubes B and on these return connections, positioned on the end of each tube, are flanges which may be readily removed and the interior of each of the tubes be examined and cleaned.

C, C^1, C^2, C^3, are check valves positioned on the different lines.

D, and D^1 are pressure regulating valves.

E^1 to E^{14} inclusive and E^{17}, E^{18} and E^{19} are throttle valves.

F, F^1, F^2, F^3, F^4 and F^5 are pyrometers.

G, G^1, to G^6 inclusive are pressure gauges.

H, H^1, H^2, H^3, H^4 are glass liquid gauges.

J, J^1, are steam pumps; K is the discharge line from the heating coil B to the tank K^1. K^2 is the overflow from tank K^1 to tank K^3, and connected with K^2 is line K^4 to tank K^5 having positioned on its valve E^5. K^6 is suction line connecting pump J^1 to tank K^3 and connecting with suction line K^6 is suction line K^7 connecting it with tank K^5 and on these two suction lines are positioned valves E^6 and E^7.

L is discharge line from pump J^1 to the heating tubes B and L^1 is the discharge line from pump J to tank K^1.

M is the suction line to pump J. N is the draw-off from the bottom of tank K^3, a similar one being positioned on the bottom of tank K^5.

P are the vapor lines from tanks K^1, K^3 and K^5 leading to a reflux air-condenser Q.

Q^1 is a header on the lower end of the air condenser and Q^2 is a header on the upper end of this condenser which are connected by the slanting tubes Q^3, and out of the header Q^2 extends vapor line P^1 connecting with the condensing coils R positioned in the water cooling tank R^1 and extending into the top of tank S and extending out of the top of tank S is gas line S^1. Q^4 and Q^5 are doors in the housing surrounding the tubes Q^3 of the reflux air condenser Q, these doors being for the purpose of controlling the amount of air circulated around the tubes Q^3.

T is a line extending from the end of the header Q^1 into the tank K^3 with branch T^1 extending to tank K^5.

W is a line extending from the bottom of the header Q^1 into the bottom of the suction line K^6 or can be drained into the tank X, X^1, X^2 and X^3 are supports for the different parts of the apparatus.

Y is a line entering the discharge pipe L through which steam or water or both are injected from any suitable source of supply, Y^1 being another line for a similar purpose. Z and Z^1 are steam lines to pumps J and J^1.

Now describing the operation of the process, the material to be treated is drawn from any suitable source of supply through line M, through pump J, through line L^1 into the different parts of the apparatus until the proper amount of the material to be treated has been charged into the said apparatus, which amount should be sufficient to fill the heating tubes B, and tank K^1 to overflow into tank K^3 and tank K^5 to overflow suction line K^6 so that suction line K^6 will always be covered while pump J^1 is in operation. Pump J is then shut down for the time being and pump J^1 is put into operation and by this means the oil is circulated through discharge line L into and through the heating tubes B then through line K into and through tank K^1 to overflow K^2 into and through K^3 and then to overflow suction K^6, into and through pump J^1 and so on as above described. Fire is placed in the furnace A and maintained at a proper temperature, which temperature will range from 400 to 2400° F. The specific temperature that will be used in any one case will depend on many things, such as the volume of oil treated in any given period of time also on the velocity at which the oil is passed through the heating tubes B also on the character of the material being treated.

As the oil passes through the heating tubes B it is subjected to the proper heating and then is passed up through the oil contained in the tank K^1 and the vapors liberated in this tank pass out through the vapor lines P while the oil overflows from tank K^1 through overflow pipe K^2 into tank K^3 and the vapors liberated while the oil is passing through tank K^3 pass up through the vapor line P into the header Q^1 through air cooled tubes Q^3 and into header Q^2 and from there through pressure valve D' through condensing coils R into receiving tank S from which the distillate is drawn either continuously or intermittently through valve E^9, while the uncondensable gas is drawn off through line S^1. K^5 is a tank similar in detail to tank K^3, and is so connected with the apparatus by means of overflow pipe K^4 and overflow suction pipe K^7 and vapor lines P, that either or both of these tanks can be used or either be cut out and cleaned while the other is in use and the apparatus maintained in operation. For instance, tank K^3 can be cut out of the apparatus by the closing of the valves E^2, E^7, E^3 and E^{19} which will cut out the tank K^3 and by opening valves E^5, E^4, E^6 and E^{17} will put in commission the tank K^5 and the tank K^3 can then be cleaned; and reversing the opening and shutting of the above mentioned valves will put tank K^3 back in operation and cut out tank K^5. The vapors condensed in the header Q^2 and the connecting pipes Q^3 and header Q^1 will flow into the header Q^1 and then be drained back into tank K^3 or tank K^5 according to which is in operation, and any water condensed along with this distillate will be collected in header Q^1 and can be drawn off through line W into tank X by the closing of valve E^{10} and the opening of valve E^{11} or it may be returned to the apparatus into the bottom of suction line K^6 by opening valve E^{10} and closing E^{11}, or the distillate collected in Q^1 may be handled in the same way. As the oil passes through tank K^3 or tank K^5 and while the volume passing through this tank in any given space of time, is as great as the oil passed through

the heating tubes B in the same given time, yet the mass movement in the tank K^3 or tank K^5 will be so much slower that the oil will not be able to carry in suspension the amount of free carbon or other solids that it was able to carry in suspension while passing through the heating tubes B and therefore this excess carbon or other solids will settle out in said tank K^3 or tank K^5 and be drawn off with the residuum through line N and which residuum can be drawn off either intermittently or continuously, or no residuum at all is drawn off and the free carbon and other solids allowed to collect in the bottom of the tanks K^3 or K^5, and when an accumulation has been attained in either of these tanks, that particular tank can be cut out from the apparatus, as already described, and the said tank be cleaned and then put into operation and in the meantime the free carbon and other solids will accumulate in the other tank in the same manner. A fresh supply of raw material may be fed either continuously or intermittently into the apparatus through line M through pump J, through discharge line L^1 into the bottom of tank K^1. It will be observed that the incoming charging stock passes into the tank K^1, and then into either the tanks K^3 or K^5, thereby absorbing some of the heat of the oil for the purpose of preheating the charging stock and perhaps also vaporizing out low boiling point ends. Steam or water or both may be fed into the apparatus through line Y into discharge line L either continuously or intermittently.

The higher the velocity at which the oil is circulated through the heating tubes B, the higher will be the additional pressure on such oil while in said tubes over and above such pressure maintained on the rest of the apparatus, and in order to increase the pressure above that additional pressure that will be created on the oil by the velocity that it is desired to maintain the oil at in the heating tubes, I have placed a pressure regulating valve on the discharge line of these tubes and marked it D.

It will be seen that my method herein described permits of the continuous treatment of petroleum wherein such petroleum is repeatedly subjected to a heating zone under a higher pressure than is maintained elsewhere on the apparatus, such heated oil repeatedly percolated up through a body of oil, repeatedly passes through a settling tank, and while passing through the latter two places the oil freed of its vapor contents which pass up in a reflux condenser wherein the heavy vapors are condensed and automatically returned to the apparatus while the remaining vapors pass on through the water cooled condenser and are collected separately, while the remaining unvaporized oil and condensate from the reflux condenser are again subjected to further heat treatment. It will also be seen that by my herein described method the distillates from the reflux condenser can be returned to the oil in the settling tank or returned practically direct to the suction side of the circulation pump. It will further be seen that by my method herein described I can use either water or steam or both in the heating tubes and such water condensed in the reflux condenser, trapped and withdrawn from the apparatus or automatically returned back to the heating tubes. It will also be seen by my herein described method that I can distil practically all the oil put into the apparatus without withdrawing from the apparatus any substantial amount of liquid residue, but continue to feed fresh raw material into the apparatus and yet not plug my heating tubes with carbon. It will also be seen that by my method herein described the grade of final distillate allowed to pass from the process is definitely controlled by means of the reflux condenser.

The pressure that can be used on the apparatus will vary from zero to 1000 pounds per square inch, but in all cases the pressure on the oil while passing through the heating tubes will be more than the pressure maintained on the rest of the apparatus, and where such rest of the apparatus is over the pressure of one atmosphere, then such pressure is reduced to atmospheric pressure at D^1. It will be understood that the pressure maintained on the apparatus will be governed by the boiling point of the products produced, and the quantity produced, and the temperature to which the oil is subjected in the heating tubes and whether heated in connection with water or steam or both, and these will vary according to the raw material used, all of which are of very considerable commercial value. In the method and apparatus here shown it will be noted that the condensation of the final product in the water condensing and receiving tank takes place at atmospheric pressure.

It will be understood that while I herewith furnish drawings and describe certain apparatus, yet I do not limit myself to any particular construction of apparatus or arrangement of same.

The heating coils B are from 2″ to 4″ in diameter. The tank K^1 is approximately 3′ in diameter and 10′ high. The settling tanks K^3 and K^5 are 10′ in diameter more or less. Charging the heating tubes with gas oil from the mid continent field, having a gravity of about 32° to 34° Baumé, and subjecting the same to a heat of approximately 850° in the heating tubes and discharging the cracked oil therefrom to K^1, a yield of 50% to 60% low boiling point distillate may be obtained, it being understood that the system is maintained under a pressure of from 100 pounds to 150 pounds. By re-distilla-

tion of this condensate about 50% low boiling point hydrocarbon oils having a boiling point of approximately 400° F. may be obtained.—

What I claim as my invention is:—

1. A process for the conversion of hydrocarbon oils, which consists in heating a mass of relatively heavy hydrocarbon oil to a cracking temperature above the boiling point of the complex chemical constituents of said heavy oil under sufficient pressure to prevent vaporization of said chemical constituents, introducing said heated oil into a zone of lower pressure in such a manner as would permit vaporization of said chemical constituents and checking the dissociation of said heated oil by the regulated introduction of a cooler mass of hydrocarbon oil into physical contact therewith substantially at the point of vaporization.

2. A process for the conversion of hydrocarbon oil which consists in heating a body of relatively heavy hydrocarbon oil to a cracking temperature, in maintaining a pressure on said oil to prevent vaporization of a substantial proportion thereof while such oil is undergoing a cracking reaction, in introducing said heated oil into a zone of reduced pressure where vaporization thereof would ordinarily occur, and in checking the cracking and vaporization of said heated oil by the introduction of a cool mass of hydrocarbon oil into said heated oil substantially as it enters said zone of reduced pressure.

3. A process for the conversion of hydrocarbon oils, which consists in heating a stream of oil to a cracking temperature above the boiling point of the complex constituents thereof, in preventing a substantial vaporization of said heated oil while maintained at a cracking temperature to sufficiently convert the same and under a superatmospheric pressure, in introducing the heated oil to a zone of reduced pressure in such a manner as would permit a substantial vaporization of said constituents, and in checking the vaporization of said heated oil by the introduction of a regulated quantity of cooling medium in direct physical contact with said heated oil at the point where pressure is reduced.

4. A process for the conversion of hydrocarbon oils, which consists in heating a mass of relatively heavy hydrocarbon oil to a cracking temperature above the boiling points of the complex chemical constituents of said heavy oil under sufficient pressure to prevent the vaporization of any substantial portion of said chemical constituents, introducing said heated oil into a zone of lower pressure in such a manner as would permit vaporization and dissociation of said chemical constituents, and checking the dissociation of said heated oil by the regulated introduction of a cooling agent to said oil in direct physical contact therewith at the point of vaporization.

5. A process for the conversion of hydrocarbon oils consisting of heating a stream of oil to a cracking temperature, in maintaining such oil under a pressure sufficient to prevent vaporization of a substantial portion of the oil when said oil is at a temperature above its boiling point at atmospheric pressure, discharging the heated oil into a zone of lower pressure, in simultaneously introducing cooling oil in physical contact with said hot oil, in said zone of lower pressure in a regulated quantity and in such a manner as to substantially check the vaporization of said hot oil, in discharging the resultant products into a pool of oil of a temperature lower than the temperature of said products at the time they enter said pool.

CARBON P. DUBBS.

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Dec. 24, 1929. C. J. GREENSTREET 1,740,691

APPARATUS AND PROCESS OF TREATING HYDROCARBON OILS

Original Filed Aug. 4, 1917 3 Sheets-Sheet 1

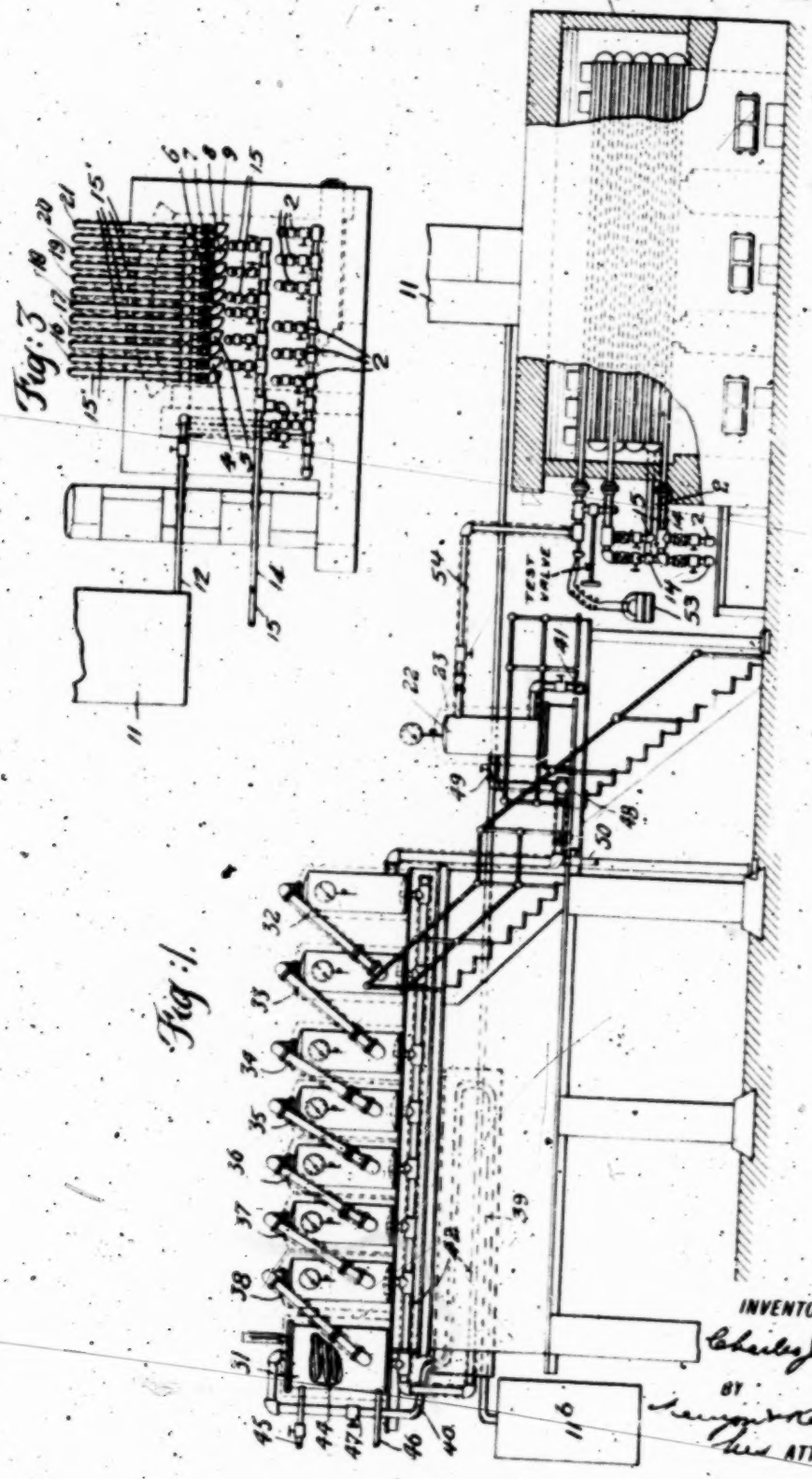

Fig: 1.

Fig: 3

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Dec. 24, 1929. C. J. GREENSTREET 1,740,691

APPARATUS AND PROCESS OF TREATING HYDROCARBON OILS

Original Filed Aug. 4, 1917 3 Sheets-Sheet 2

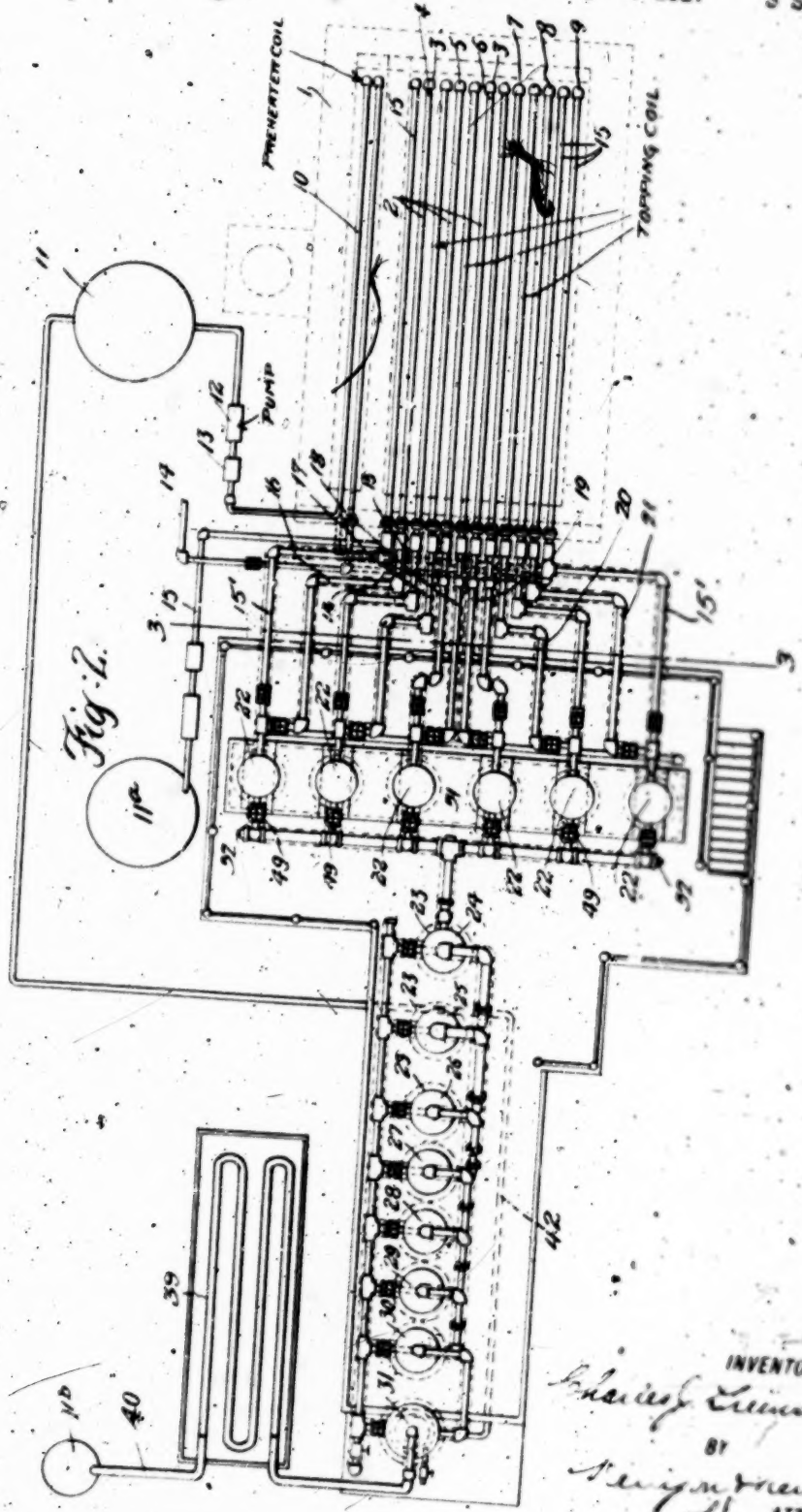

Fig. 2.

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APPARATUS AND PROCESS OF TREATING HYDROCARBON OILS

Original Filed Aug. 4, 1917 3 Sheets-Sheet 3

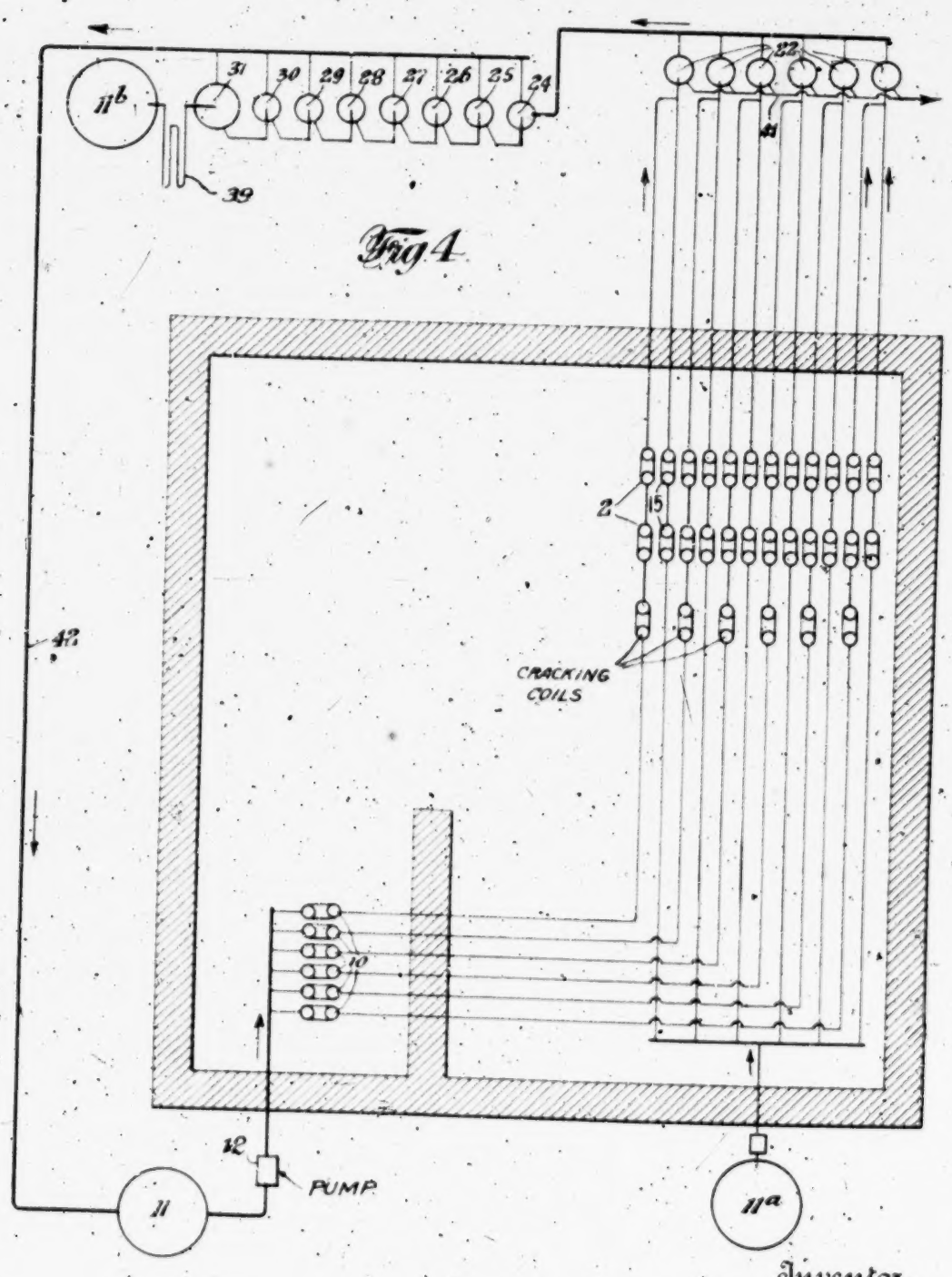

Fig 4

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Patented Dec. 24, 1929

3481 1,740,691

UNITED STATES PATENT OFFICE

CHARLES J. GREENSTREET, OF NEW YORK, N. Y., ASSIGNOR TO GASOLINE CORPORATION, A CORPORATION OF DELAWARE

APPARATUS AND PROCESS OF TREATING HYDROCARBON OILS

Application filed August 4, 1927, Serial No. 184,379. Renewed March 13, 1929.

My invention relates to the treatment of hydrocarbon oils and particularly to the process and apparatus therefor.

One of the objects of my invention is to reduce the cost of operation of processes for cracking hydrocarbon oils, and is especially useful in reducing the fuel consumption and increasing the percentage of light hydrocarbons recovered with a minimum amount of labor.

One way of accomplishing this result is by heat insulating the passage from the furnace to the exit.

The following description of the process and apparatus taken in connection with the accompanying drawings forming a part hereof, will more fully convey my invention and the manner in which the same is operated.

In the drawings, Fig. 1 is a side elevation.

Fig. 2 is a plan view.

Fig. 3 is an end elevation of the furnace showing the connection of the vapor lines.

Fig. 4 is a diagram showing the connection of pipes as given in the other figures of the drawings.

In the drawings, the apparatus comprises a furnace 1, in which are located a plurality of cracking units 2. The furnace may be of any suitable construction and may be heated by coal or other fuel as desired, the furnace forming no part of the present invention. The cracking units placed in the furnace are so arranged that the passage is a continuous, unobstructed one, preferably consisting of a series of straight pipes of suitable diameter joined together by semicircular end connections 3.

The equipment shown in the accompanying drawings comprises six units, each unit comprising a cracking coil 4, 5, 6, 7, 8 or 9, to which is connected a preheater 10. The length of this preheater is such that the oil under treatment is brought to the vaporizing point just as it enters the cracking pipe. Each preheater is connected to a suitable storage tank 11 from which the supply is taken. In each pipe line from the storage tank is a steam pump 12 and a meter 13 as well as suitable valves for controlling the supply. Connected with each cracking unit is a steam pipe 14, which pipe is so arranged that the steam, before entering the cracking unit, is super-heated. This steam pipe also has suitable valve connections for controlling the flow of steam.

There is provided in the furnace a series of crude oil or distillate topping coils 15, one for each cracking unit. These coils are shorter in length than the cracking coils and the contents are therefore subjected to the heat of the furnace a comparatively shorter time than the contents of the cracking coils. It is the purpose of these topping coils to heat the crude oil or distillate preferably above its vaporizing point. The vapors from these coils are conducted through the digester tanks as will be more fully explained later. The heavier fractions are deposited in the various succeeding tanks and the benzine fraction taken off and conducted to a condenser. From each of the cracking coils a vapor line 16, 17, 18, 19, 20 or 21 leads to tanks 22. As all of the cracking units are alike, a description of one will suffice for all.

The digester tanks 22 and all other parts of the pipe system and tanks are heat insulated by some suitable compound 23 in any well known manner. All the digester tanks 22 are connected by a suitable pipe with a series of other digester tanks 24, 25, 26, 27, 28, 29, 30 and 31. In each case the pipes connecting the tanks are heat insulated as well as all the digester tanks. The top of each of the digester tanks 24 to 31 is connected to a lower portion of each succeeding tank by connections 32, 33, 34, 35, 36, 37 and 38, and the top of the last digester tank is connected to condenser coils 39, which condenser coils are cooled in any suitable manner. The final product leaves the apparatus through the pipe 40 in the form of benzine, which is conducted to a suitable storage tank 11—B.

Connected to the bottom of all of the digester tanks 22 is a header 41 into which the heavier products settle or condense, and which are not re-run through the furnace. Connected with the bottom of all of the digester tanks 24 to 31 inclusive is a header 42 in which the heavier ends settle out or condense. The header 42 leads to a condenser

coil which is suitably cooled, and this condensed product, which may be termed an intermediate product is conducted to a suitable storage tank, from which it is rerun through the cracking coils.

Located within the last digester tank 31 is a cooling coil 44 having an inlet 45 and an exit 46. Through this pipe, water or other suitable cooling fluid can be conducted so as to regulate the temperature of the last of the digester tanks. The tank 31 is provided with a thermometer so that the temperature may be suitably indicated. Each of the digester tanks is provided with a pressure gauge so that the pressure may be observed. This pressure is controlled by a valve 47 which is connected to the last of the digester tanks.

Each of the digester tanks into which the individual cracking units or the vapor lines terminate, is connected with a header 48, which in turn is connected with the first of the series of digester tanks 24 to 31. Each of the connections from the digester tanks to the header 48 is provided with a valve 49. These valves are for cutting out a cracking unit in case of accident.

While I have shown the apparatus arranged so that there is only one series of digester tanks, I wish it to be understood that my invention contemplates the use of a series of tanks for each cracking unit, in which event each digester tank 22 would connect directly with its own series of digester tanks. In the header 48 opposite the connection to the digester tanks is a plug 51 for steam connection, which would permit the application of a steam pipe at this point for the purpose of blowing steam through the digester tanks for the removal of impurities. Each end of the header 48 is provided with a steam plug 52.

Each of the vapor lines leading from the cracking coil to the digester tanks 22 is provided with a pyrometer 53. The header leading to the digester tanks 24 to 31 is provided with a suitable draw-off valve 50.

It is understood that all of the connections from the furnace to the very end of the series of digester tanks are thoroughly heat insulated, so that the heat given to the oil in the furnace is conserved and kept within the piping system with as little loss as possible. It is understood further that because of the relative difference in cross-sectional capacity between the digester tanks and the cracking and tapping pipes the vapors will move more rapidly through the pipes than through the digesters, and since the process is carried out under pressure, the vapor may move with considerable rapidity in the tubes, the speed being under control by the valves in the pipe line. It is obvious also that since the digester tanks have a materially greater diameter than the coils and pipe connections, they serve as expansion chambers where the gas movement is slowed down.

The operation of the apparatus is as follows:

The crude oil is first run from the tank 11ª through the topping coils and during its course through these coils 15 which are located in the furnace is heated to at least a point above the vaporizing point of the benzine fraction. These vapors are then conducted through the vapor lines 15′ to the digester tanks 22 and from these tanks into the header 48 and thence successively through the series of digester tanks 24—31. During the above defined course, the tars or asphalts settle out in the digester tanks 22 and the vapors continue on down through the series of tanks 24—31, a portion, comprising in each case the heavier ends, of the vapors from each tank being condensed in, and collecting in, the next succeeding tank. The last tank contains only benzine vapors, which are thence led to the tank 11ᵇ. The condensed products which are led into the header 42 are then conducted through pipe 42 to the distillate storage tank 11. The oil is conducted from the storage tank 11 into the preheater coils 10 and is vaporized approximately upon leaving the preheater. It is then conducted in vapor form and accompanied by steam through the cracking coils 2 where it is heated to a high temperature under pressure. Usually, in starting the apparatus, steam is blown through for some suitable length of time before the oil is admitted to the cracking coil. From the cracking coil, the vapors are conducted to the digester tanks 22, and from these tanks they are conducted through a passage of comparatively small diameter into the first of the series of digester tanks, 24—31, and from this point, the vapors pass successively from tank to tank as above explained.

By the use of the process as above described, the heavier fractions, which are not transformed into lighter fractions in the cracking coil, due to the rapid velocity of the contents through the cracking coils, are converted into lighter fractions during the course of the vapors through the various digester tanks, so that upon leaving the digester tanks, an unusually large percentage of the oils is transformed into lighter hydrocarbons and due to the heat insulated passage through which they are conducted, the fuel consumption for heating the oil under treatment is greatly reduced and due to the prolonged exposure of the particles to a high temperature while under pressure, the unusually large conversion above mentioned is accomplished.

The topping coils can also be used as cracking coils by running an excess of super-heated steam through the topping coils and running the distillate more slowly through the topping coils, in which event a substantial increase in percentage of benzine would result.

In practice, I have found that when, as shown, about eight tanks are used the last three or four tanks would act in the capacity of a fire still, the heat in the tanks being higher than the volatilizing point of the benzine causes a distillation from these tanks over to the last tank, so that the distillates separating out in the last three or four tanks contain no benzine and should the last tank contain too much of the heavy ends, due to the benzine carrying over mechanically some of the heavy ends distilling, the cooling coil in the last tank serves to precipitate out the heavy ends, and the benzine vapors pass into a condenser coil and thence to a run-down tank ready for further treatment in the usual manner of handling benzine.

While I have described the apparatus and process in more or less detail, I desire to have it understood that I am not limited to the exact arrangement shown. For instance, while the digester tanks, 24—31 have been shown in a plane above the digester tanks 22, all of these tanks may be located on the same level, and various other changes of similar character may be made without in the least departing from the spirit of my invention.

While the apparatus above described, shows no application of external heat, other than in the furnace, it is to be understood that I may, nevertheless, add some heat to the piping system at suitable points, if desired.

Having described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. The process of treating hydrocarbon oil which consists in subjecting the oil in a vaporized state, in a plurality of conduits to a temperature sufficient to crack the oil, conducting the oil from each coil to separate expansion chambers, and thereafter conducting the vapor from each expansion chamber to a single digester chamber.

2. The process of treating hydrocarbon oils which consists in passing oil through coils to vaporize the oil, passing the oil vapors into tanks containing hot cracked vapors, and passing the resulting mixture through successive heat insulated tanks in which the heavier portions are condensed and separated, passing the separated condensed portions through coils under pressure and raising said condensed oils to a cracking temperature, passing the resulting cracked vapors into said tanks and mixing them therein with said vaporized oils.

3. The process of treating hydrocarbon oil which consists in subjecting the oil in a vapor state, in a plurality of conduits to a temperature sufficient to crack the oil, conducting the oil vapor from each of said conduits to a separate digestion tank, and thence to a plurality of tanks connected in series, the concentration of the oil vapor in the series of tanks being greater than that in the separate digestion tanks, all of said tanks being heat insulated to conserve the heat energy of the oil vapor and permit additional cracking thereof.

4. The process of treating hydrocarbon oil which consists in subjecting the oil in a vapor state, in a plurality of conduits to a temperature sufficient to crack the oil, conducting the oil vapor from each of said conduits to a separate digestion tank and thence to a plurality of tanks connected in series, the concentration of the oil vapor in the latter tanks being greater than that in the separate digestion tanks, all of said tanks being heat insulated to conserve the heat energy of the oil vapor and permit the additional cracking thereof and repeatedly passing the heavier condensed portions of the oil vapors through the circuit, including the conduits and tanks.

5. In an apparatus for treating oil, the combination of a plurality of cracking pipes in parallel, means for heating said pipes, a plurality of heat insulated expansion chambers one connected with each cracking pipe, means connecting said chambers together, a valve controlling the pressure in all of said chambers and means for withdrawing liquid from said chambers.

6. The process of cracking hydrocarbon oils, which comprises passing hydrocarbon oil through a heating zone and then into a chamber containing hot cracked vapors, separating the resulting vapor mixture from unvaporized residue, withdrawing unvaporized residue from the system and conducting the vapor mixture into a vapor-separating zone in which the higher boiling portions of the vapors are condensed and separated, passing the resulting condensate through a second heating zone under pressure and vaporizing and heating the same to a cracking temperature, and passing the resulting cracked vapors into said chamber wherein they are mixed with the constituents of said hydrocarbon oil.

7. The process of cracking hydrocarbon oils in the vapor phase which comprises bringing preheated topped crude oil into intimate contact with the hot oil vapors resulting from the vapor phase cracking of a hydrocarbon oil, separating vapors from unvaporized residue oil, withdrawing said residue and passing the resulting separated vapor mixture into a vapor-separating and condensing zone in which the heavier portions of said vapors are condensed and separated, passing said separated condensate into a vapor phase cracking zone in which the condensate is vaporized and cracked by heat in vapor phase to produce at least in part said hot oil vapors, and passing the resulting hot cracked vapors into contact with said preheated topped crude oil.

8. The process of cracking hydrocarbon

oils, which comprises preheating hydrocarbon oil in one zone and conducting the same into a chamber in contact with hot cracked vapors, separating the resulting vapor mixture from unvaporized oil in said chamber, withdrawing the unvaporized oil from said chamber and conducting the separated vapor mixture into a vapor condensing zone in which the higher boiling portions of the vapors are condensed and separated, vaporizing resulting condensate and heating the vapors to a cracking temperature in a second zone maintained at a temperature adapted to crack the condensate vapors, and passing the resulting cracked vapors while at a high temperature into said chamber wherein they are contacted with said preheated hydrocarbon oil.

9. The combined process of topping crude petroleum and cracking a distillate thereof, which comprises heating crude petroleum to a temperature sufficient to vaporize portions of its lower boiling constituents, thereafter mixing the vaporized and unvaporized constituents of the crude petroleum with hot cracked oil vapors in a contact zone, separating the resulting vapor mixture from residue oil in said contact zone, conducting the separated vapor mixture into a vapor condensing zone in which portions of the higher boiling point constituents are condensed and separated, separately heating and cracking the condensate from said condensing zone to produce said hot cracked oil vapors, and mixing them with the heated constituents of said crude petroleum.

In testimony whereof, I have signed my name to this specification.

CHARLES J. GREENSTREET.

CERTIFICATE OF CORRECTION.

Patent No. 1,740,691. Granted December 24, 1929, to

CHARLES J. GREENSTREET.

It is hereby certified that error appears in the above numbered patent requiring correction as follows: In the heading to the printed specification, line 5, date of filing application should read "August 4, 1917", instead of "August 4, 1927"; and that the said Letters Patent should be read with this correction therein that the same may conform to the record of the case in the Patent Office.

Signed and sealed this 24th day of June, A. D. 1930.

(Seal)

M. J. Moore,
Acting Commissioner of Patents.

1,765,976

3486

June 24, 1930. R. A. HALLORAN ET AL 1,765,976

PROCESS OF CRACKING PETROLEUM OILS

Original Filed Sept. 4, 1925

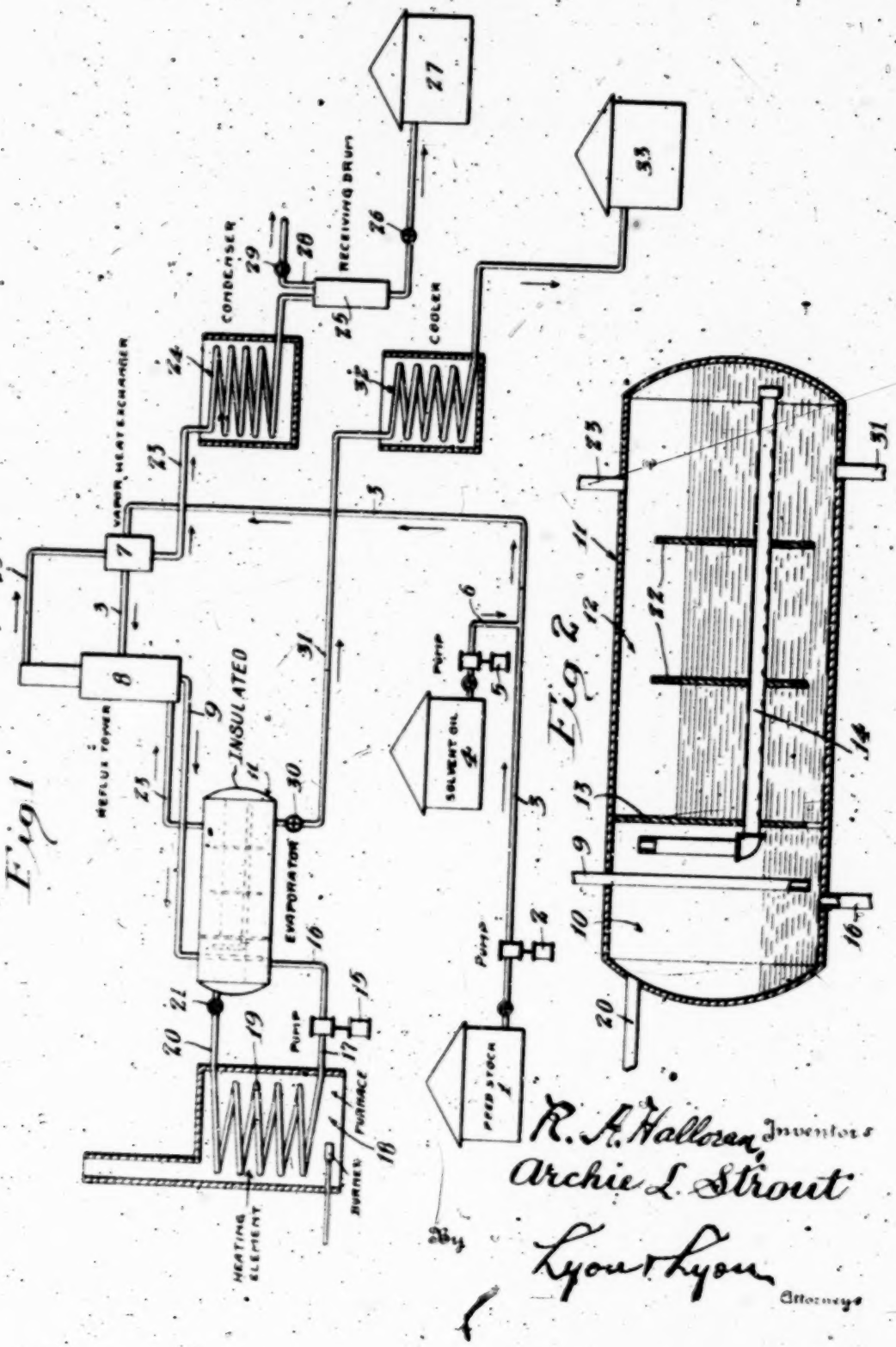

Fig 1

Fig 2

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Patented June 24, 1930

3487

1,765,976

UNITED STATES PATENT OFFICE

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PROCESS OF CRACKING PETROLEUM OILS

Application filed September 4, 1923, Serial No. 660,828. Renewed December 5, 1927.

This invention relates to the art of decomposition or "cracking" high-boiling-point petroleum oils by the application of heat and pressure for the production of relatively low-boiling-point oils.

In nearly all "cracking" processes in which high temperature is employed, development has long been towards the use of relatively small tubes or banks of tubes for the heating element. In the use of such a heating element two methods have been employed to raise the oil to the temperature of the desired "cracking" reaction: One,—a single or direct passage of the oil through such heating element in a series flow and thence to a vessel or point where vaporization takes place, and, the other,—a continuous circulation or cycling of the oil, either thermo-siphonic or forced circulation, through a closed circuit, including such heating zone or element, to and from a vessel or chamber where vaporization takes place. Cycling with forced circulation, in combination with certain other specified conditions, has heretofore been practiced. In 1891 pressure "cracking" with forced circulation, in combination with continuous feed, continuous withdrawal of residuum, and continuous distillation with condensation under atmospheric pressure, was disclosed by Schuchow and Gavrilow in Russian Patent No. 4782 (No. 175 of 1891). Since then various other combinations with forced circulation have been disclosed in the patent literature.

In those processes using forced circulation, as employed heretofore, deposition of carbon in the heating element or tubes has seriously interfered with the successful operation of such processes in that it has limited the length of time during which the process and apparatus can be run before shut-down for carbon removal from the heating element becomes necessary, and has reduced the heat transfer through the element to the oil undergoing heating therein, seriously affecting the efficiency of the heating element, and decreasing the heat absorption rate which must be corrected by increasing the fuel supply to the heating element, thereby rendering control of the operation exceedingly difficult or impossible and thus affecting not only the chemical reaction but also the yield of the desired low-boiling-point oils.

It has been found that with many of such processes and the apparatus for carrying out the same, carbon deposition is a limitation on the yield for any given charging stock beyond which it is not economical to carry on the operation. Any provision by which the carbon deposition in the tubes is reduced prolongs the length of the run for the same yield and charging rate and for the same length of run produces a higher yield.

It has been customary in the method heretofore utilized in which a cyclic process with continuous withdrawal of tarry residuum is employed, to withdraw such residuum from the same chamber or compartment in which vaporization takes place and from which the circulation of the incoming fresh feed starts. As a result of this the tarry residuum withdrawal, instead of being substantially free from low-boiling-point oils is a representative or average sample of the mixture in the vaporizing chamber or compartment and contains, therefore, in addition to the tarry residuum and fresh stock, unvaporized low-boiling-point oils. This also results in an undue proportion of the tarry residuum, resulting after vaporization has taken place, being circulated through the heating coils along with the fresh feed and partially "cracked" oils thereby causing an increased degree of carbonization in the coils. Futhermore, with such cyclic process it has been the general practice to maintain in the vaporizing chamber or compartment such a relatively large volume of the oil undergoing treatment as compared with the volume of oil in circulation as to prevent the whole body of oil subjected to cycling to be repeatedly subjected to reheating, thereby affecting the heat control of such menstruum and tending to create an undesirable heat differential between the oil as it is circulated and the oil in the vaporizing chamber. This is for the reason that, if the oil in the vaporizing chamber of the process is to be maintained at substantially

uniform temperature by a circulation of oil from said chamber through a heating zone and back into said chamber, the oil in the heating zone must be heated to a temperature substantially higher than that of the oil in the chamber to supply the necessary heat of vaporization to the oil in the chamber unless the oil is very rapidly circulated through the heating zone, so that although the oil passing through the heating zone is only heated slightly above that of the vaporizing chamber, such a great volume of oil is circulated therethrough that the total additional heat carried thereby to the vaporizing chamber is sufficient to supply the heat demand in the vaporizing chamber. With a relatively large volume of oil undergoing treatment it is difficult to maintain this condition without such high rate of circulation as tends to prevent the oil in the vaporizing chamber assuming even a substantially quiescent state and thus any carbon formed therein will be mechanically carried into the circulating path and to the heating zone and will not properly settle out from the chamber where it can be removed.

In United States Patent No. 1,449,227, granted to Richard W. Hanna on March 20, 1923, there is described a cyclic process wherein is employed to material advantage in commercial operation while passing the oil through the heating zone or element at intervals of not substantially more than ten minutes, a pressure and temperature in excess of that at which the oil is held at the point at which the cycling or circulation begins.

In United States Patent No. 1,408,698, dated March 7, 1922, granted to Richard W. Hanna, there is described a cyclic process in which "solvent oil" is used to material advantage.

Our invention relates to an improvement in the respective processes of said Letters Patent Nos. 1,408,698, and 1,449,227, although our invention is not necessarily limited to use as an improved process embodying the invention patented or described in either of said patents.

We have discovered that by maintaining a relatively small volume of the oil undergoing treatment in the direct path of the circulation and by so conducting the operation that only the heavy derivatives produced by the initial vaporization of the circulating menstruum are in the path of circulation or subject to being drawn into such circulation, and the reaction is completed in a substantially separate chamber under substantially the same conditions of temperature and pressure so that the further products formed by the completion of the reaction are not subject to being drawn into the circulation, a material reduction in the carbon or coke deposition or formation in the heating tubes is secured and we are able to substantially increase the yield of low-boiling-point products. Also we effect thereby a saving in fuel. We are also able thus to segregate the high-boiling-point derivatives of the "cracking" reaction or tarry residuum from the menstruum being cycled and withdraw the same substantially without any effect from these heavy derivatives or tarry residuum upon the circulating menstruum.

Our invention will be best understood by reference to the accompanying drawings, which are used merely to illustrate a preferred embodiment of our invention and which, it is understood, may be widely varied without departing from the spirit of the invention, and in which Figure 1 is a diagrammatic view of an apparatus by which my invention may be practiced.

Fig. 2 is an enlarged cross-sectioned view of the evaporator, showing more in detail the cycling or initial vaporizing chamber and the separate final vaporizing chamber.

In the drawing, 1 indicates a storage vessel for the high-boiling-point oil which is to be "cracked"; 2 is a suitable pump designed to pump such oil from the storage, 1, and force the same through pipe or conduit 3. 4 indicates a storage vessel for a solvent oil which is to be mixed with the high-boiling-point oil to be "cracked" for the purpose of taking into solution the heavy bodies produced by "cracking" such high-boiling-point oil and preventing such heavy bodies from being so reduced as to cause deposition in the system, all as more fully explained in U. S. Patent No. 1,408,698, granted on March 7, 1922. Such "solvent" oil may be any lower-boiling-point oil which shall be substantially unaffected at the pressure and temperature employed in the "cracking" of the particular oil operated upon. The use of such solvent oil is incident, however, only to the preferred form and embodiment of my process. 5 indicates a pump to force solvent oil through line 6 into line 3, where it is mixed with the oil to be "cracked." It is obvious, however, that the mixing of the oil to be "cracked" and the solvent oil may take place before the same are supplied to the storage or supply tanks of the system, in which case the mixture is forced directly into pipe 3. From the pipe or conduit 3, this charging stock is forced into and through a waste heat exchanger 7, and thence through a continuation of such pipe or conduit 8, into a reflux condenser 8, where such charging stock is subjected to the waste heat of the reflux condenser and where it joins with the reflux and flows through pipe 9 into the vaporizing chamber 10 of the drum 11.

The heating coil or element 19 of the

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"cracking" system is preferably mounted in a suitable furnace 18, which may be heated in any preferred manner; 15 indicates a pump which takes suction on the vaporizing chamber 10 through pipe 16, and causes a stream of the liquid therefrom to be circulated through pipe 17, heating coil 19, and pipe 20, back to the vaporizing chamber 10. 21 indicates a suitable valve, by means of which a differential pressure may be maintained on the oil in the vaporizing chamber 10, and the heating coil 19. 13 represents a baffle extending across the drum 11, and so located that the vaporizing chamber 10, is relatively small as compared with the compartment 12. This baffle completely closes off the vaporizing chamber 10, from the compartment 12, except for a small opening about six inches in diameter next to the lowest point on the periphery of the drum 11. 14 represents a bank of tubes arranged in a horizontal plane and extending through the baffle 13. These tubes are closed on the end located in compartment 12. The other end is open and is upturned, so as to extend above the level of the liquid kept in the vaporizing chamber 10. Within the final reaction and vaporizing chamber 12 the bottoms of these tubes 14 are provided with suitably spaced small openings through which the vapor, evolved in the initial vaporizing and cycling chamber 10, is forced to flow into the body of reacting oil in the chamber 12. These tubes 14 are to be tightly welded to the baffle 13 to insure the forcing of the passage of all such vapor from chamber 10 through tubes 14 into chamber 12. The maximum level of oil in the chamber 10 is determined by the level of the discharge openings from the tubes 14 into the chamber 12. The level of reacting oil in the chamber 12 is regulated by the withdrawal of residual oil therefrom and the maximum level of oil in chamber 10 is not dependent upon the level of oil in chamber 12. Baffles 22 are for the purpose of breaking up convection or eddy currents in compartment 12.

A vapor line 23, extends from compartment 12 to the reflux condenser or column 8, and thence through heat exchanger 7 to condenser 24. The condensate flows into a receiving drum 25, where the fixed or uncondensable gases are released through conduit 28 and valve 29. The condensate is released through valve 26 and passes to storage 27. 31 represents a discharge pipe through which tarry residuum is withdrawn continuously from the system and passed through the cooler 32 to storage 33. The withdrawal of this tarry residuum is controlled by valve 30.

With such an organized apparatus or system as thus illustrated and described, we maintain in the cycling chamber 10 of the evaporator 11 and in the final vaporizing chamber 12 substantially the same pressure, differing at most by the pressure of that head of liquid in the up-turned end of pipe 14, which difference in pressure is not substantial insofar as any effect upon the character of cracking reaction effected is concerned. The pressure of the operation may be selected by the operator to accord with the cracking operation desired. When my process is performed in such a system, we preferably maintain in the final evaporating chamber a relatively large volume of the re-acting oil undergoing vaporization. Preferably we conduct the vapors from the cycling chamber 10 into the final evaporating chamber in such manner as to discharge them into this body of oil as, for instance, by means of the vapor conduit pipes 14. By thus discharging these hot vapors into and causing them to rise through this body of re-acting oil vaporization thereof is assisted and an economy of the heat demand effected. Thus a further reduction in the potential formation of carbon or heavy derivatives in the heating element is secured and an increased yield for the same charging rate is thus secured. The final withdrawal of the low-boiling-point vapors is from this final evaporating chamber 12. The withdrawal of the heavy derivatives of the cracking operation is also from such chamber 12 and preferably as far removed as possible from the actual cycling menstruum of the system. The reacting oil is maintained for an appreciable time in this chamber 12 and the main precipitation or settling out of the carbon, tarry bodies or heavy derivatives or cracking takes place therein. The period of re-action is thus prolonged by the reaction of the oil in the final evaporating chamber 12, as described, without permitting this prolonged reaction, and the consequent precipitation and settling out of the oil of the heaviest derivatives, to effect the operation of the cyclic system, which includes, as before described, a heating zone or coil and a cycling chamber, in which latter material vaporization is effected.

However, our invention is not necessarily limited to conducting the vapors from the cycling or initial vaporizing chamber into the re-acting oil in the final vaporizing chamber. If desired such vapors may be permitted to flow from the cycling chamber over into the vaporizing space above the reacting oil in the final chamber 12, as by providing a suitable opening (not shown) at or near the top of the baffle 13, or they may be separately discharged, as through a vapor outlet, (not shown in the drawings), from the cycling chamber 10, connected with a reflux tower, etc.

It will be apparent in the practice of this process that a very considerable amount of vaporization will take place in the vaporizing chamber 10. The vapors here formed include the lighter or desirable fractions, and, in addition, a large proportion of heavier products, which will later be returned to the system as reflux from the tower 8, all of which vapors must of necessity pass through the tubes 14 and into the oil in compartment 12 of the system.

It will further be apparent that the oil passing from compartment 10 through the opening in the baffle 13 into the compartment 12 will be held at a cracking temperature. This oil is withdrawn at the chamber 10 from the circulating menstruum of the system. The rate of withdrawal is determined by the rate of withdrawal of the heavy derivatives of cracking from the chamber 12 plus the rate of withdrawal of vapor formed in the chamber 12, from the chamber 12, less all condensation in the chamber 12 of vapor entering thereinto through the conduits 14.

There will be a slight fall in temperature due to small radiation losses and to heat absorbed by additional vaporization and reaction in this compartment 12. It is this additional reaction and vaporization which so greatly adds to the increase in yield of the process and makes it possible to withdraw a residuum substantially free from constituents desired as distillates. The construction of drum 11 is but diagrammatically indicated, it being understood that in practice the drum must of course be supported upon a suitable foundation and in accordance with ordinary refinery practice would be suitably insulated against dissipation of heat by radiation or convection.

Very satisfactory results have been obtained by the use of this process including the use of baffle 13 but without the use of the tubes 14 in which case a vapor opening is arranged at the top of baffle 13 as before referred to. It has been found, however, that the fall of temperature in the oil in compartment 12 is greater and the increase in yield less than with the use of the vapor tubes 14.

While we have shown in the drawings the cycling and initial vaporizing chamber 10 and the final reacting and vaporizing chamber 12 as parts of a single element, indicated in the drawing as an "evaporator," it is obvious that the functions and mode of operation of these would not be changed nor would the process be materially altered if the initial vaporizing and cycling chamber 10 and the final reaction and vaporizing chamber 12 were constructed as totally independent units and merely so connected as to have the described functions and functional relations to each other and to the process and system as a whole. We, therefore, wish it understood that in so far as the drawings illustrate or we have herein described these two chambers as parts of a single element, such has been done conventionally and for convenience and we do not thereby limit our invention thereto.

Preferably condensation of the vapors in the condenser 24 is under pressure maintained on the system by regulation of the valve 26. The cracking operation may be performed at any required temperature and under such pressure above atmospheric as may be best suited to the particular conditions and oils to be treated.

In the preferred embodiment as stated above, the reflux is joined with the feed and is introduced into and becomes a part of the circulating menstruum. The menstruum is thus maintained substantially free from heavy and tarry bodies and the difficulties resulting from carbon deposition substantially reduced. It is apparent, however, that the feed and reflux may be introduced into other parts than those indicated.

We claim:—

1. The cyclic process of cracking petroleum oils under a substantially constant temperature and pressure, both of which are substantially uniform throughout the cracking system, which includes forcibly circulating the oil undergoing treatment in a relatively small stream from an initial vaporizing and cycling chamber through a heating zone and back into said chamber, passing a portion of the oil in circulation from said cycling chamber to a non-cycling chamber, in such manner as to maintain in said cycling chamber a relatively small volume of oil and in said non-cycling chamber a relatively large volume of said oil in order that heavy derivatives are formed mainly in said non-cycling chamber, effecting the completion of the desired cracking reaction in said non-cycling chamber, withdrawing the vapors, and withdrawing residual oil.

2. The cyclic process of cracking petroleum oils under constant temperature and pressure, both of which are substantially uniform throughout the cracking system, which includes forcibly circulating the oil undergoing treatment in a relatively small stream from an initial vaporizing and cycling chamber through a heating zone and back into said chamber, feeding the oil to be treated to said circulation in sufficient quantity to maintain a substantially uniform volume of oil in circulation, withdrawing a portion of the partially converted oil from the circulating menstruum at said cycling chamber and passing it to a second reacting and vaporizing chamber, maintaining such oil in said second chamber for a time sufficient to permit the completion of the desired reaction and under the

required conditions of pressure and temperature without recirculation, withdrawing the vapor, and withdrawing residual oil.

3. The cyclic process of cracking petroleum oils under constant temperature and pressure, both of which are substantially uniform throughout the cracking system, which includes forcibly circulating the oil undergoing treatment in a relatively small stream from an initial vaporizing and cycling chamber through a heating zone and back into said chamber, feeding the oil to be treated to said circulation in a sufficient quantity to maintain a substantially uniform volume of oil in circulation, withdrawing a portion of the partially converted oil from the circulating menstruum at said chamber and passing it to a second reacting and vaporizing chamber, maintaining liquid communication between said chambers, maintaining a closed condition against the withdrawal of vapor from said cycling chamber except through the second chamber and through the reacting oil therein, withdrawing the vapor from said second chamber, and withdrawing residual oil from said second chamber.

4. A process of cracking petroleum oils under a substantially constant temperature and pressure, both of which are substantially uniform throughout the cracking system, which includes first forcibly circulating the oil undergoing treatment from a vaporization and cycling chamber through a heating zone and back into said chamber, continually withdrawing a portion of the oil from such circulating system and passing it to a cracking chamber in which a relatively larger volume of oil is maintained than in said vaporization and cycling chamber, the oil in said second chamber being maintained in a quiescent state to permit removal of residuals, the vapor formed in the first chamber being passed through the oil in the second chamber, feeding the oil to be treated to said circulation in sufficient quantity to maintain substantially a uniform volume of oil in circulation, withdrawing the vapors formed, and withdrawing residual oil from said second chamber so as to remove heavy derivatives therefrom.

5. A cyclic process of cracking petroleum oils which includes heating the oils undergoing cracking by circulating the oils from an evaporating chamber to and through a heating zone and back into the evaporating chamber, passing a portion of the heated oil to a second chamber in which the cracking reaction is continued while maintaining the oil quiescent and withdrawing residual oil from said second chamber at such a relation of volume and speed as to remove the heavy derivatives from said second chamber and to regulate the flow of oil from said first chamber to said second chamber, and withdrawing the vapors.

6. In the pressure distillation of oils heavier than gasoline for the production of gasoline-like products, maintaining a plurality of bodies of oil and causing oil to flow successively therethrough, withdrawing oil from the first of said oil bodies, passing it through a heating zone in which it is brought to conversion temperature and returning it in heated state to said first oil body to maintain all said oil bodies at cracking temperature, the later oil bodies deriving heat solely from said oil passed through the heating zone.

7. In the pressure distillation of oils heavier than gasoline for the production of gasoline-like products, maintaining a plurality of bodies of oil and causing oil to flow successively therethrough, withdrawing oil from the first of said oil bodies, passing it together with fresh oil through a heating zone and returning such oil in heated state to said first oil body to maintain all said oil bodies at cracking temperature, the later oil bodies deriving heat solely from said oil passed through the heating zone.

8. In the pressure distillation of oils heavier than gasoline for the production of gasoline-like products, maintaining a plurality of bodies of oil and causing oil to flow successively therethrough, said oil bodies being at conversion temperatures, removing vapors therefrom, cooling said vapors to condense therefrom products heavier than the desired gasoline-like products, withdrawing oil from the first of said oil bodies, passing it together with said heavier products condensed from the vapors through a heating zone and returning such oil in heated state to said first oil body to maintain all said oil bodies at cracking temperature, the later oil bodies deriving heat solely from said oil passed through the heating zone.

Signed at Richmond, California, this 28th day of August, 1923.

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Oct. 18, 1932. O. BEHIMER 1,883,850

PROCESS FOR MAKING GASOLINE

Original Filed Nov. 21, 1918

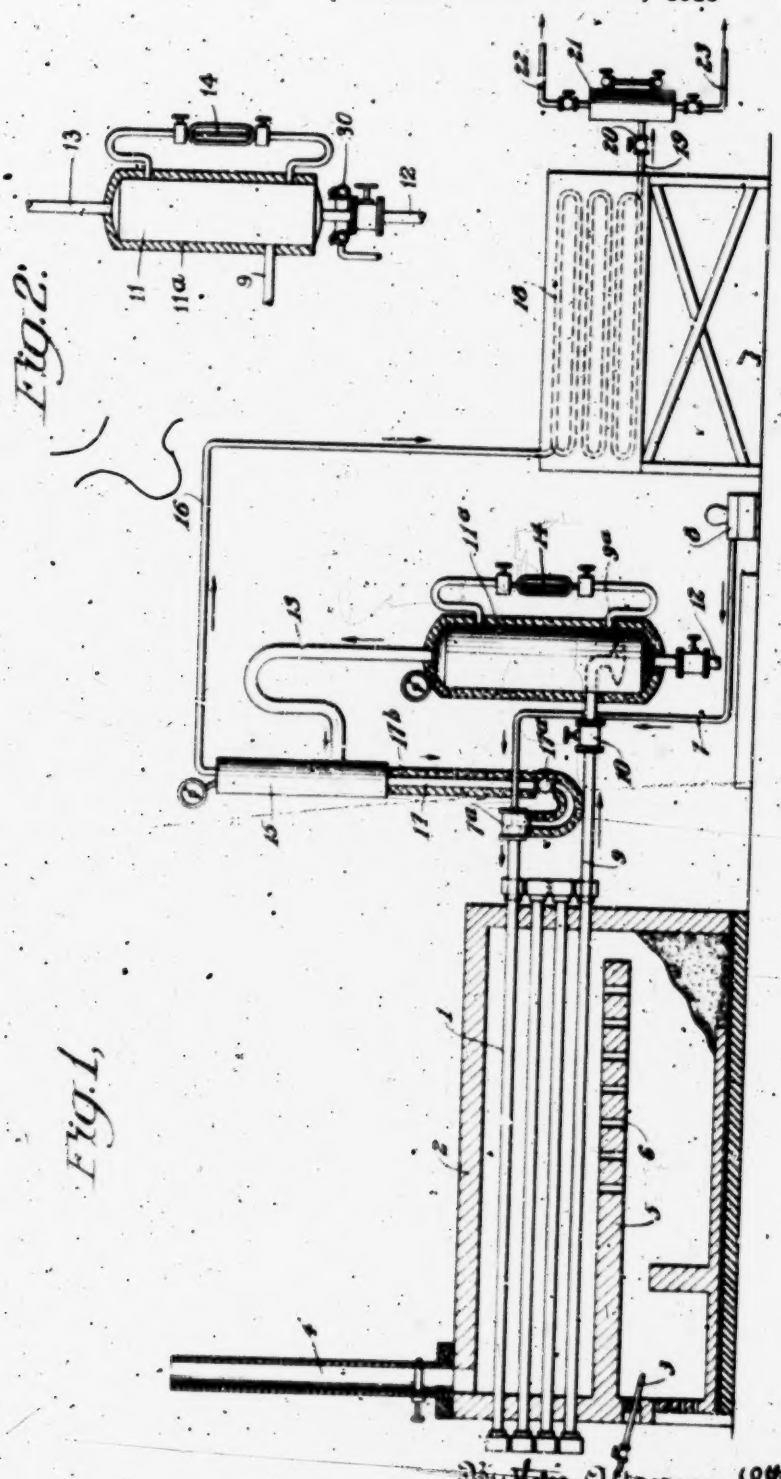

Fig. 2.

Fig. 1.

Inventor

By their Attorneys Otto Behimer

Barlow

Patented Oct. 18, 1932

1,883,850

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UNITED STATES PATENT OFFICE

OTTO BEHIMER, OF PORT ARTHUR, TEXAS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO THE TEXAS COMPANY, OF NEW YORK, N. Y., A CORPORATION OF DELAWARE

PROCESS FOR MAKING GASOLINE

Original application filed November 21, 1918, Serial No. 263,562, and in Canada December 3, 1921. Divided and this application filed April 6, 1922. Serial No. 550,242.

This invention relates to methods of making condensable light oils, such as gasoline. More particularly it relates to certain novel improvements in the cracking of hydrocarbons whereby higher boiling hydrocarbons are decomposed into those of lower boiling point.

This application is a division of my copending application, Serial No. 263,562, filed November 21, 1918.

In prior methods of cracking hydrocarbon oils, considerable difficulty has been experienced on account of carbon formations, which occur on the sides of tubes and stills exposed to the heat required to carry on the cracking operation.

It is a broad novel feature of the herein disclosed process that substantially all of the cracking operation occurs in a vessel to which no external heat is applied, except at such times and in such quantities as are necessary to compensate for heat losses, the oil prior to its introduction to such vessel having been subjected to a high degree of cracking heat and the excess heat of the oil itself being used to effect its own decomposition. As a consequence, I avoid substantial carbon formations of the destructive character which have proved such an impediment to prior systems. The removal of the cracking operation from the heating zone also reduces the danger from fires such as frequently occur where cracking is carried on in highly heated stills and coils exposed to direct heat.

More specially my process preferably embodies a novel cyclic system in which a circuit of oil is constantly maintained under varying liquid and vapor phases. The oil to be treated on entering this circuit is subjected to a high degree of heat, but the time element is so controlled with respect thereto that there is comparatively little decomposition and deposition of carbon while it is exposed to this external heat, the oil being rapidly removed from the heating zone and conducted to the cracking zone, where without necessarily being subjected to additional heat, it undergoes a molecular decomposition whereby carbon and light products are formed and liberated. It will be understood that oil cracking or conversion is dependent not only upon the relative conditions of pressure and temperature but also upon the time element with respect thereto, that is,—the necessary pressure and temperature must be maintained for a sufficient period of time to enable the molecular decomposition or conversion to take place. According to the present invention, this time factor is so controlled, by regulating the rate of heating the oil passing through the heating zone that the temperature thereof is progressively raised in transit and reaches the desired cracking temperature near the end of the heating coil at about the time or a little before the oil emerges therefrom. Thus, although the oil is subjected to cracking heats in the heating zone, this temperature is attained only just previous to the exit of the oil therefrom, and therefore, the oil leaves the heating coil before any substantial decomposition and incident deposition of carbon takes place. Subsequently, the highly heated oil in a state of incipient decomposition, is delivered to the cracking zone, where the desired temperature and pressure conditions are continuously sustained and the cracking of the oil and the incident decomposition of carbon are effected. The bulk of the carbon is removed from the circuit by withdrawing from the cracking zone, portions of the residual oil. Although the process, in its broad conception, is complete at this stage of the operation, the light products preferably continue the cycle, leaving the cracking zone in the form of vapor and gas. These vapors and gases are then subjected to a reduction in temperature, whereby the heavier constituents thereof, such as kerosene, are condensed. The condensate preferably is combined with the charging oil entering the heating zone, thus completing the cycle. The constituents of the desired volatility are removed from the circuit and condensed. The outlets from the circuit are so controlled that the entire system is maintained under a pressure sufficient to insure the desired molecular transformation.

My process is to be distinguished from those of the prior art, in which a circuit of liquid residuum is kept in circulation. When such oil is kept in circulation, considerable quan-

tities of carbon are formed, owing to the readiness with which this type of oil carbonizes when exposed to high temperatures, the carbon forming in fine particles in the oil, and wherever it comes in contact with heated metal surfaces, it attaches itself thereto and builds up deposits, which often cause the choking of tubes and coils. It also crystalizes the metal surfaces, thereby decreasing the tensile strength of the metal and causing the bulging and breaking of such surfaces. Any residual oil resulting from the cracking operation will necessarily contain a considerable amount of heavy polymerization products and carbon held in suspension in the oil, and to circulate such a residue through heated tubes is to continually pass into or produce in such tubes a large amount of free carbon. In my system, I do not circulate a residuum, but instead keep the residual oil removed from the application of external heat and withdraw the heavier portions thereof, which contain the bulk of the carbon, from the cycle at the cracking zone, and continue the cycle by means of the vapor generated, which contains the condensable product desired and also certain heavier vaporous constituents which are used to complete the cycle. By removing the heavier residuum from the cycle, I keep the circuit free from this source of carbon formation, and since I conduct substantially all of the cracking in a vessel to which either no external heat is applied or only a small quantity of heat is applied to maintain the requisite temperature conditions, I am thus able to effectively remove the carbon formed.

In cracking oil for gasoline, there is generally formed a considerable quantity of vapors heavier than gasoline, which may be generally designated by the term, kerosene. I preferably employ these heavier vapors as a carrier for the lighter vapors; they assist in maintaining a current of vapor by which the gasoline is removed from the cracking zone to a separator where the kerosene vapors are condensed and removed from the gasoline vapors which pass on to the condenser. The kerosene condensate, preferably at a temperature, not materially below its boiling point, is injected or otherwise suitably forced under mechanical pressure into the heavy oil charge entering and flowing through the heating tubes whereby a foamy agitated mixture is produced by the acceleration of the circulation in the heating tubes resulting from the increased volume of oil therein, thereby preventing the settling and flow of the heavier portions of the oil along the bottom of the highly heated tubes and the consequent local overheating and carbonization of the oil, thus keeping the tubes substantially free from any slight carbon formations. These kerosene constituents are an excellent mechanical conductor of heat, and there is thus produced a heat cycle which materially assists in maintaining the proper temperatures in the heating and cracking zones. By maintaining these bodies in constant circulation, the kerosene constituents, which under existing methods have been found so difficult to decompose into lighter products, are, in my system, ultimately reduced to gasoline.

I have devised certain novel apparatus which is adapted for carrying out my process, and illustrate the preferred form thereof in the drawing in which,

Figure 1 is a diagrammatic elevation of said apparatus;

Figure 2 is a diagrammatic view of a modified cracking drum which may be substituted for that of Figure 1.

It will be understood that other apparatus besides that illustrated may be used in carrying out my process.

Referring to Fig. 1 of the illustrative drawing, a tubular heating coil 1 is located in a furnace 2, having a burner 3 and a stack 4. As shown for illustrative purposes, the coil 1 comprises a plurality of horizontally disposed rows of tubes extending through the furnace and placed the one above the other. The adjacent ends of each alternate pair of tubes in each horizontal row are conveniently connected together by horizontally positioned return bends or fittings to form horizontal coils. The several horizontal coils thus arranged are conveniently connected together at their right-hand ends by vertically disposed return bends or fittings, as shown in Fig. 1, to form a single elongated and continuous heating coil through which the oil flows and is heated to the required degree. This coil is of extended length and restricted cross-section and has a relatively large and effective heating surface whereby the stream of oil passing therethrough is enabled to efficiently absorb heat and reach a high temperature with rapidity. A checkered brick baffle 5 having openings 6 may serve to distribute the heat evenly over the coil. A fresh oil charging line 7, having a jet or injector 7ª, extends to a pump 8, which is connected to a suitable source of oil supply (not shown). The pipe 9, having a valve 10, extends from the heating coil 1 to an enlarged cracking drum or chamber 11, within which it may terminate in a distributor 9ª. This distributor 9ª may be of any suitable form to thoroughly distribute and diffuse the charging oil throughout the body of oil in the drum whereby an intimate contact of the highly heated charging oil with the body of oil in the drum is effected. The cracking drum is preferably provided with a jacket 11ª of suitable insulating material to protect it against heat radiation and is equipped with a valved draw-off 12, a vapor outlet 13, and an oil gauge 14. The vapor outlet 13 extends to a separator 15, having a vapor outlet 16, and a condensate outlet

17. The vapor line 16 terminates in a water-cooled condenser coil 18, having an outlet 19 equipped with a regulatable pressure valve 20. If desired the valve 20 may be placed in the vapor line 16 but I prefer to maintain the pressure in the heating coil, cracking drum and separator through the condenser. The outlet 19 terminates in a collecting tank 21, having a valved gas outlet 22 and a valved distillate outlet 23. The condensate line 17, which is preferably insulated, as indicated at 17^b is equipped with a valve 17^a and is connected to the charging line 7 at the jet 7^a.

In conducting the process with the apparatus illustrated, the oil to be treated is forced through the charging line 7 under considerable pressure, and is rapidly flowed through the heating coil 1, where it is heated to the desired cracking temperature. Preferably this temperature is somewhat higher than the temperature at which it is desired to conduct the cracking operation and may or may not result in substantial vaporization. The oil on being forced through the coil acquires a high cracking temperature, but on account of the rapidity of its flow, decomposition is only in the incipient stages when the oil is discharged through the pipe 9 into the heat insulated cracking drum 11 where a constant body of oil is maintained at a cracking temperature under pressure. The distributor 9^a if employed serves to discharge the oil into the cracking drum in a wide stream, thus thoroughly mixing the hot oil with the liquid body of oil maintained in the drum and diffusing the heat therethrough. This heat diffusion is materially aided by using a distributor with serrated edges. The rapid flow of the oil through the coil where it is closely confined is here suddenly retarded, as the oil enters the drum which is of ample volume. Thus the excess heat of the oil operates to maintain the body of oil at the desired cracking temperature and molecular decomposition and distillation are carried on vigorously, the higher boiling hydrocarbons continually breaking up into hydrocarbons of lower boiling point. The vapors and gas generated gather in the upper part of the cracking drum and pass out through the vapor outlet 13 to the separator 15, where there is effected a separation of hydrocarbons of desired volatility from those of less volatility. The hydrocarbons of the desired volatility pass out through the vapor line 16, by which they are conducted to the condenser 18, where they are condensed, and the condensed distillate is either intermittently or preferably continuously allowed to run into the collecting tank 21.

The temperature in the air condenser 15 is such that the less volatile hydrocarbons are condensed and dropped into the conduit 17, by which they are conducted while still hot to the jet in the charging line or other suitable forced or applied mechanical pressure device for forcing the condensate into the charging stream. The separator is preferably somewhat elevated so as to give a considerable head of liquid in the pipe 17, which preferably contains a U bend, as illustrated, in order to form a liquid seal therein. This head of liquid, together with the high pressure at which the oil in the charging line passes the jet, this pressure being ordinarily from 50 to 100 pounds higher than the pressure in the drum, insures that the condensate shall be constantly and positively drawn into the charging line and forced under applied mechanical pressure into the coil 1. The introduction of this hot condensate into the charging line increases the volume of oil in the heating coil and thereby accelerating the flow therein and producing a foamy mixture so that local overheating is prevented and the coil is kept substantially free from any slight carbon formations. This condensate consists in a type of hydrocarbons which when decomposed does not yield any great amount of carbon so that the oil charge is constantly being diluted with oil capable of being decomposed into lighter products without the production of large amounts of carbon. This condensate reaches the jet in a heated condition, preferably at a temperature not materially below its boiling point, so as to heat the charge of oil entering the heating coil. The heat cycle formed by the kerosene constituents contributes to the maintenance of the proper temperatures in the heating coil and the cracking drum. By injecting or otherwise suitably forcing this condensate under applied mechanical pressure into the heating coil I increase the volume of oil flowing therein without increasing the total amount of oil charged into the system at any given time.

A considerable pressure is maintained throughout the system, which pressure is regulated by means of the valve 20 or the valve on the gas outlet 22. The pressure used varies with the character of the oil operated on and the character of the product desired. Ordinarily the decomposition in the cracking drum is carried on under a pressure of from 100 to 400 pounds. In utilizing oils of the type commonly employed for decomposition into products of the nature of gasoline a temperature in the drum 11 of from 700° F. to 850° with a temperature in the coil 1 of from 700° F. to 950° F. is ordinarily used. For example, in cracking a paraffin base gas oil of a Baumé gravity of about 34°, a temperature of 850° F. in the coil and of 775° F. in the drum with a pressure of approximately 200 pounds has been used to advantage.

The oil to be decomposed is constantly forced into the heating coil thereby causing a steady stream of heated oil to enter the cracking chamber. The residuum is with-

drawn preferably at such a rate that there is maintained a constant body of oil in the cracking zone.

It is desirable to equip the apparatus with the valves 10 and 17 so that in case there is a break in the heating coil the effect of any fire resulting may be localized by closing said valves, whereby the bulk of oil in the system will be retained in the cracking drum 11. It is understood that in the normal operation of the process these valves are open.

Auxiliary heat may be supplied to the cracking drum in any suitable manner if desired, and a convenient method of providing this auxiliary heat is, as shown in Fig. 2, to insulate only the upper part of the drum and apply heat at a moderate temperature or in a relatively small quantity from any suitable heater such as is designated 30. The lower portion of this drum may be enclosed in a furnace. In the early stages of a run, since there is no danger of overheating a carbon-free surface, the drum may be heated freely until the necessary heat cycle has been generated and decomposition has begun. For this reason the arrangement of Fig. 2 possesses certain advantages over that of Fig. 1. But when decomposition begins, with a consequent deposition of carbon, the heat must be reduced, as otherwise the carbon would accumulate on the hot surfaces and build up tenacious formations thereon, thus preventing the effectual removal of the carbon and asphaltic bodies. As the run continues only a moderate heat is applied, sufficient only to offset the loss of heat due to radiation and distillation. If desired the drum may be heated by means of waste heat from the furnace 2 or in any other suitable manner.

The product obtained by the herein disclosed process is, for a cracked product, remarkably sweet, in other words, low in unsaturated compounds.

It is understood that I use the terms gasoline and kerosene in this application by way of example and that these terms are taken as types of other similar distillates which may be produced by my process. I use the term gasoline as an example of the volatile product desired which under the temperatures and pressures used is a vapor in the separator 15 and is condensable in the cooling coil 18. I use the term kerosene as an example of those constituents which under the temperatures and pressures used is a vapor in the vapor line 13 but is condensable in the separator 15. It is to be noted that the gravity and boiling point of the products which will condense in the separator 15 depends upon the temperature therein under the pressures used.

Although for illustrative purposes the invention has been shown and described in connection with apparatus of more or less specific details of construction, arrangement and location of parts, and as embodying in its mode of operation a certain series and sequence of somewhat definite steps and operating conditions, it will be understood that many of the objects and advantages of the invention may be obtained, to a greater or less extent, through the employment of apparatus of modified character or, in fact, through variations or, in some cases, omissions, of certain of the component steps, without departing from the spirit and scope of the invention.

What I claim is:

1. The continuous method of converting hydrocarbons which comprises forcing charging oil under superatmospheric pressure through a heating coil and regulating the heating therein so that it is raised to a cracking temperature, removing said oil from the coil before any material decomposition sets in and conducting it to a vessel maintained under superatmospheric pressure and not subjected to external heat where cracking is carried on by means of the heat contained in the oil, removing from the cracking zone residuum and vapors formed, separating the less volatile constituents of the latter and forcing them into the charging oil entering the heating coil.

2. The process of converting hydrocarbon oil which comprises continuously forcing oil through a heating coil at a rapid rate of flow, continuously removing said oil from the coil before material cracking takes place and introducing it into a body of oil while in its heated condition to maintain said body of oil at a temperature sufficient for decomposition without depending upon the application of other external heat thereto, removing residuum and vapors formed, separating out the heavier vapors as a condensate and continuously forcing it under maintained mechanical pressure into the heating coil, while maintaining a pressure of substantially 100 to 500 pounds throughout the system.

3. The process of converting hydrocarbon oil which comprises passing oil once through a heating coil where the oil acquires a high cracking temperature, continuously removing said oil from the coil and introducing it into a substantially constant body of oil whereby said body of oil is maintained at a somewhat lower cracking temperature and is subjected to decomposition, removing from said body of oil residual bodies and vapors formed, separating out the heavier of said vapors as a condensate and continuously forcing it free of residual oil and under maintained mechanical pressure into the heating coil, while maintaining a pressure of substantially 100 to 500 pounds throughout the system and continuously supplying charging stock to the process.

4. A process of oil conversion that comprises maintaining a body of oil under super-

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atmospheric pressure at a cracking temperature in a drum by continuously supplying oil at a comparatively high cracking temperature but substantially free from decomposition into the body of oil in said drum to be cracked therein, preventing loss of heat from said drum, distilling and condensing the gasoline and kerosene fractions, separating out the kerosene fractions and returning them under maintained mechanically applied pressure and free of residual oil to the incoming supply.

5. A process of oil conversion that comprises maintaining a liquid body of oil under superatmospheric pressure at a cracking temperature in an unheated drum, insulating the drum against loss of heat and supplying unconverted oil to the drum through a highly heated coil, the rate at which the oil is heated in the coil being regulated to avoid substantial decomposition of the oil therein, withdrawing vapors from said drum, forcibly returning the heavier constituents of said vapors in liquid form and under maintained mechanical pressure to the coil, condensing the lighter constituents of said vapors under superatmospheric pressure and preventing the return of residual oil to said coil.

6. A process of oil conversion that comprises charging oil at high speed through a coil into a cracking drum, applying high temperature heat to the coil to raise the temperature of the oil so that it is delivered to the drum at a cracking temperature but without substantial decomposition, maintaining a body of liquid oil under superatmospheric pressure and at a cracking temperature in said drum to produce decomposition thereof, continuously withdrawing the vapors from the drum, separating the kerosene-like constituents from the lighter vapors, returning the kerosene-like constituents by applied mechanical pressure to the coil for passage therethrough with the charge, condensing the lighter vapors, and preventing the return of residual oil to said coil.

7. A process of oil conversion that comprises passing charging oil rapidly in a single passage through a highly heated coil and into a cracking chamber maintained under superatmospheric pressure to which no high temperature heat is applied during the cracking operation, withdrawing residue from said chamber, passing the vapors from the chamber into a separator, forcibly returning the heavier constituents of said vapors while under maintained pressure and without material drop in temperature, with the fresh charging oil into the coil, and preventing the return of residue to said coil.

8. The continuous method of cracking hydrocarbon oils which comprises charging a stream of oil into a cracking still to maintain a body of oil therein, maintaining the oil therein under superatmospheric pressure and at a cracking temperature, removing the evolved vapors, separating out the heavier constituents thereof and cyclically returning them to the still for further treatment by positively forcing them into the stream of charging oil being supplied to the still.

9. The process of oil conversion that comprises maintaining a substantially constant body of oil in a still at a cracking temperature and superatmospheric pressure and under distillation, by continuously supplying oil thereto through a heating coil in which the oil is raised to a comparatively high cracking temperature in a single passage, separating out the heavier distillation products in the form of a hot condensate and forcing it while still hot and under maintained mechanical pressure into the coil for retreatment, preventing the return of residual oil to the coil and continuously supplying charging stock to the process.

10. A process of oil conversion that comprises passing the oil once through an extended heating zone of restricted cross-section where it is raised to a cracking temperature and thence into a cracking and distilling zone where a body of liquid oil is maintained, decomposed and distilled, separating the heavier constituents of the evolved vapors and without substantial drop of temperature or pressure, forcibly returning them to the heating zone for retreatment, removing residue from the cracking zone while preventing recirculation of residue through the heating zone, and maintaining superatmospheric pressure through the heating and cracking zones.

11. A process of oil conversion that comprises passing the oil through an extended heating zone of restricted cross-section where it is heated to a cracking temperature, delivering the heated oil into an unheated cracking and distilling zone, separating the heavier constituents of the evolved vapors and returning them without substantial drop in pressure or temperature under mechanical pressure to the heating zone for retreatment, preventing recirculation of residue through the heating zone, maintaining superatmospheric pressure through the heating and cracking zones and continuously supplying charging stock to the process.

12. A process of oil conversion that comprises passing the oil once through a heating coil where it is raised to a cracking temperature and into a drum where a substantially constant body of liquid oil is maintained and vapors evolved, separating the heavier constituents of the evolved vapors and returning them while still hot and without substantial drop in pressure under mechanical pressure to the heating coil for retreatment, removing residuum from the drum while preventing recirculation of residuum through the coil, maintaining super-

atmospheric pressure through the coil and drum and continuously supplying charging stock to the process.

13. A process of oil conversion which comprises converting the oil under cracking temperature and superatmospheric pressure, condensing the heavier constituents of the evolved vapors, mixing the condensed constituents free of residual oil and while in heated condition and under mechanical pressure with the fresh charging oil, and heating and delivering the heated mixture to the cracking zone for conversion.

14. A process of oil conversion that comprises forcing a stream of oil under superatmospheric pressure once through an elongated heating zone of restricted cross-section, applying heat to the oil in transit therethrough to raise the oil to a cracking temperature, delivering the heated oil into an unheated enlarged zone where a substantially constant body of liquid oil is maintained under superatmospheric pressure and at a cracking temperature, discharging the residual oil produced in the process, removing the evolved vapors from said enlarged zone, separating out the heavier constituents thereof in the form of a hot condensate and returning said condensate while still hot and free of residual oil for retreatment by positively forcing it into the elongated heating zone against the back pressure developed therein and continuously supplying charging stock to the process.

15. The process of oil conversion that comprises maintaining a body of oil under superatmospheric pressure in a cracking chamber where a cracking temperature is maintained, by continuously forcing a stream of charging oil therein through an elongated heating coil wherein the oil is raised to a cracking temperature, the rate of heating the oil flowing through the heating coil being such as to avoid substantial deposition of carbon therein, separating out the heavier constituents of the evolved vapors and cyclically returning them for retreatment by positively forcing them under maintained mechanical pressure into the charging stream ahead of the heating coil and against the relatively high back pressure developed therein.

16. The process of oil conversion that comprises maintaining a body of oil in a chamber at a cracking temperature, continuously charging fresh oil therein at a rapid rate through an elongated charging line of restricted cross-section, maintaining superatmospheric pressure upon the oil in the chamber whereby a higher back pressure is developed in the elongated charging line by reason of the frictional resistance of the charging stream flowing therethrough, removing the evolved vapors from the cracking chamber, separating out the heavier constituents under substantially the pressure of the chamber and cyclically returning the separated condensate to the cracking chamber for retreatment by positively forcing it into the charging stream of fresh oil at a point in the charging line remote from the chamber and against the relatively high back pressure therein.

17. A process of oil conversion that comprises forcing a stream of charging oil under superatmospheric pressure through an elongated heating coil wherein the oil is brought in a single passage to a cracking temperature, delivering the highly heated oil into a body of oil in an enlarged drum maintained under superatmospheric pressure, where the evolution of vapors takes place and carbon resulting from the cracking operation is deposited, drawing off carbon residue from said drum, separating the heavier constituents of the evolved vapors and returning them for retreatment in said coil and drum by positively forcing them into the stream of charging oil ahead of said coil.

18. A process of converting heavy into lighter hydrocarbons, which comprises passing a stream of oil through a zone where said oil is heated to a cracking temperature, passing the oil thence to an enlarged unheated zone where conversion occurs, removing the vapors, subjecting them to reflux condensation, returning reflux condensate without permitting the same to intermingle with a bulk supply of charging stock under a mechanical pressure to the heating zone for further treatment, preventing an intermingling of any residue formed in the process with the oil in the heating zone, maintaining superatmospheric pressure on the material during conversion in said heating and conversion zones and continuously supplying charging stock to the process.

19. A process of converting heavy into lighter hydrocarbons, which comprises passing a stream of oil through a coil in a heating zone where said oil is heated to a cracking temperature, transferring the highly heated oil to an enlarged unheated zone where vaporization of a substantial portion thereof occurs, passing the vapors to a dephlegmator, introducing reflux condensate from said dephlegmator without permitting said condensate to intermingle with a bulk supply of charging stock to pressure applying means to be forced under pressure through the coil in the heating zone, removing the residue formed in the process without permitting intermingling of residue with the oil in the heating coil, maintaining superatmospheric pressure on said oil undergoing conversion and continuously supplying charging stock to the process.

20. A process for converting heavy into lighter hydrocarbons, which comprises passing a stream of oil in a coil through a heating

zone where said oil is heated to a cracking temperature, transferring the highly heated oil to an enlarged unheated chamber where conversion thereof occurs, passing generated vapors to a reflux condenser, returning reflux condensate without being permitted to intermingle with a bulk supply of charging stock under a forced mechanical pressure to said heating coil, preventing a return of residual oil formed in the process to the heating coil, maintaining superatmospheric pressure on the oil undergoing conversion in said system, and continuously supplying charging stock to the process.

21. A process of converting relatively heavy into lighter hydrocarbons, which comprises passing a stream of oil through a coil in a heating zone where the oil is heated to a cracking temperature, passing the oil thence to an unheated zone where vaporization takes place, removing the vapors, subjecting them to reflux condensation, returning reflux condensate under maintained mechanical pressure to the heating zone for further cracking, removing the residue formed in the process from the system without permitting intermingling of residue with the oil in the heating zone, maintaining superatmospheric pressure on the material during treatment in said coil and chamber and continuously supplying charging stock to the process.

22. A process of converting heavy into lighter hydrocarbons, which comprises passing a stream of oil in a coil through a heating zone where the oil is heated to a cracking temperature and thence to a zone where distillation takes place, removing the vapors and passing them into a reflux condenser, returning reflux condensate free of residual oil under maintained mechanical pressure to said heating coil for further treatment therein, removing the residue formed in the process without permitting intermingling of any residue with the oil in the heating zone, and maintaining superatmospheric pressure on the oil undergoing distillation and condensation in said system and continuously supplying charging oil to the process.

23. A process of converting heavy into lighter hydrocarbons, which comprises passing a stream of oil in a coil through a zone where the oil is heated to a cracking temperature, and thence to a zone where vaporization takes place, removing the vapors and passing them into a reflux condenser, forcing both reflux condensate from said condenser under pressure and without material drop in temperature and charging stock under applied mechanical pressure in a stream through the heating coil, in removing the residue formed from the system without permitting intermingling of residue with the oil in the heating zone, in maintaining superatmospheric pressure on the oil undergoing vaporization and condensation in said system.

24. A process of converting relatively heavy into lighter hydrocarbons, which comprises passing a stream of charging oil through a coil in a heating zone where said oil is heated to a cracking temperature, passing the oil to an enlarged zone where conversion thereof occurs, introducing generated vapors to a reflux condenser, returning reflux condensate free of residual oil and mixed with charging stock under a forced mechanical pressure to said heating coil, in preventing the return of any liquid residual oil formed in the process to the heating coil, and maintaining superatmospheric pressure on the oil in said coil and said chamber.

25. A process of cracking oil, which comprises continuously passing a stream of oil through a heating coil where said oil is heated to a cracking temperature, delivering the oil to an enlarged unheated vapor chamber where vaporization takes place, removing vapors from said chamber and subjecting them to an initial condenser where portions of the vapors are condensed, subjecting the uncondensed portion of the vapors to final condensation, returning condensate from said initial condenser under applied mechanical pressure to the inlet side of said heating coil, continuously drawing off the residue formed in the process and preventing residue from returning to the heating coil and maintaining superatmospheric pressure on the oil in said heating coil, enlarged vapor chamber and initial condenser and supplying charging stock continuously to the process.

26. The process of converting hydrocarbon oil which comprises passing charging oil through a heating coil where it is raised to a cracking temperature, passing said heated oil into a body of oil in a cracking zone under superatmospheric pressure and maintained at a cracking temperature by the continual entrance therein of the stream of oil from the heating coil, removing from the cracking zone residuum and vapors formed, separating the less volatile constituents of the latter and intermingling them with the stream of charging oil entering the heating coil by forcing them therein under applied mechanical pressure, withdrawing from the circuit and condensing the lighter vapors formed, and preventing the return of residuum to the heating coil.

27. The process of converting hydrocarbon oil which comprises continuously forcing oil through a heating coil at a rapid rate of flow where it is heated to a cracking temperature, introducing it into a body of oil while in its heated condition to maintain said body of oil at a temperature sufficient for decomposition without depending upon the application of other heat thereto, removing

the vapors formed, separating out the heavier vapors as a condensate, and continuously forcing it under maintained mechanical pressure into the heating coil, while maintaining a pressure of substantially 100 to 500 pounds throughout the system.

28. The process of converting hydrocarbon oil which comprises charging oil once through a heating coil where the oil acquires a high cracking temperature, continuously removing said oil from the coil and introducing it into a cracking zone where it is maintained at a somewhat lower cracking temperature and is subjected to decomposition, separating vapors from residual oil, separating out the heavier of said vapors as a condensate, continuously forcing it under maintained mechanical pressure into the charging oil and thence through the heating coil, and preventing the return of residual oil to said heating coil while maintaining superatmospheric pressure throughout the system.

29. A process of oil conversion that comprises charging oil at high speed through a coil into an enlarged drum, applying high temperature heat to the coil to raise the temperature of the oil so that it is delivered to the drum at a cracking temperature, maintaining a body of liquid oil under superatmospheric pressure and at a high temperature in said drum to effect distillation thereof, continuously withdrawing vapors from the drum, separating the kerosene-like constituents from the lighter vapors, returning the kerosene-like constituents by maintained applied mechanical pressure to the coil for passage therethrough with the charge, condensing the lighter vapors, and preventing the return of residual oil to said coil.

30. A process of oil conversion that comprises charging oil rapidly in a single passage through a highly heated coil where the oil attains a cracking temperature, and into a cracking zone where the oil is held at a cracking temperature without material rise and cracking effected, separating the lighter constituents by vaporization from the residual oil, passing the evolved vapors through a separator, forcibly returning the heavier constituents of said vapors without material drop in pressure and under mechanical pressure with the fresh charging oil into the coil, and preventing the return of residual oil to said coil.

31. The continuous method of cracking hydro-carbon oils which comprises forcing a stream of charging oil into a body of oil in a cracking still, maintaining the oil therein under superatmospheric pressure and at a cracking temperature, discharging the residual oil from the system while preventing the return of residual oil thereto, removing the evolved vapors, separating out the heavier constituents thereof and cyclically returning them to the still for further treatment by positively forcing them into the stream of charging oil being supplied to the still.

32. The process of oil conversion that comprises maintaining a body of oil in a chamber at a cracking temperature, continuously charging fresh oil therein at a rapid rate through an elongated charging line of restricted cross-section, maintaining superatmospheric pressure upon the oil in the chamber whereby a higher back pressure is developed in the elongated charging line by reason of the frictional resistance of the charging stream flowing therethrough, removing the evolved vapors from the cracking chamber, separating out the heavier constituents under substantially the pressure of the chamber and cyclically returning the separated condensate to the cracking chamber for retreatment by positively forcing it into the charging stream of fresh oil at a point in the charging line remote from the chamber and against the relatively high back pressure therein, and withdrawing residual oil from said chamber while preventing the return of any residual oil thereto.

33. A process of oil conversion that comprises forcing a stream of oil under superatmospheric pressure through an elongated heating coil wherein the oil is brought in a single passage to a cracking temperature, delivering the highly heated oil into a substantially constant body of oil in an unheated enlarged drum maintained under superatmospheric pressure, where the evolution of vapors takes place and carbon resulting from the cracking operation is deposited, separating the heavier constituents of the evolved vapors, returning them free of residual oil for retreatment in said coil and drum by positively forcing them under maintained mechanical pressure into said heating coil, and continuously supplying charging oil to the process.

34. A process of converting heavy into lighter hydrocarbons, which comprises passing a stream of hydrocarbon oil through a zone where said oil is heated to a cracking temperature, passing the oil thence to a zone maintained at substantially the temperature of the entering oil and where conversion occurs, separating the vapors from the residue, subjecting the vapors to reflux condensation, returning reflux condensate under maintained mechanical pressure to the heating zone for further treatment, discharging the residue formed in the process while preventing an intermingling of residue with the oil in the heating zone, maintaining superatmospheric pressure on the material during its passage through said heating and conversion zones and supplying charging oil continuously to the process.

35. A process of converting heavy into lighter hydrocarbons, which comprises pass-

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ing a stream of oil through a coil in a heating zone where said oil is heated to a cracking temperature, transferring the highly heated oil into a body of oil in an unheated zone where vaporization of a substantial portion thereof occurs, passing the vapors to a dephlegmator, introducing reflux condensate from said dephlegmator, while still under pressure to pressure applying means to be forced under maintained mechanical pressure through the coil in the heating zone, removing the residue from the system without permitting intermingling of residue with the oil in the heating coil, maintaining superatmospheric pressure on said oil throughout the system and continuously supplying charging stock to the process.

36. A process of converting heavy into lighter hydrocarbons, which comprises charging a stream of oil through a heating coil where the oil is heated to a cracking temperature and thence to a zone where distillation takes place, passing the evolved vapors into a reflux condenser, returning reflux condensate under maintained mechanical pressure with said charging stream to said heating coil for further treatment therein, preventing intermingling of residual oil with the oil in the heating zone and maintaining superatmospheric pressure on the oil undergoing conversion, distillation and condensation in said system.

37. A process of converting heavy into lighter hydrocarbons, which comprises forcing a stream of charging oil through a coil in a zone where the oil is heated to a cracking temperature, and thence to an enlarged zone where vaporization takes place, removing the vapors and passing them into a reflux condenser, forcing hot reflux condensate while under maintained applied mechanical pressure into the stream of charging stock and thence through the heating coil, preventing intermingling of residual oil with the oil in the heating zone, and maintaining super-atmospheric pressure on the oil undergoing heating and vaporization in said system.

38. A process of converting relatively heavy into lighter hydrocarbons, which comprises charging a stream of oil through a coil in a heating zone where said oil is heated to a cracking temperature, passing the oil to a zone maintained at a cracking temperature where conversion thereof occurs, separating the lighter products from the residual oil by vaporization, introducing generated vapors to a reflux condenser, returing reflux condensate mixed with charging stock under a forced mechanical pressure to said heating coil, preventing the return of residual oil to the heating coil, and maintaining superatmospheric pressure on the oil undergoing conversion in said system.

39. A process of cracking oil which comprises subjecting oil in a fired heating zone to a cracking temperature solely by the application of external heat, delivering the highly heated oil into a heat insulated zone where separation of vapors from residual oil takes place, discharging the residual oil, subjecting separated vapors to partial condensation to separate out the heavier constituents thereof as a condensate, removing uncondensed vapors and positively returning condensate unmixed with residual oil by maintained mechanically applied pressure to the heating zone for further treatment and continuously supplying charging stock to the process.

40. A process of cracking oil which comprises passing oil in a stream under superatmospheric pressure through a heating coil where it is heated in transit solely by external heat to a cracking temperature, conducting the highly heated oil into an enlarged heat insulated vapor separating zone maintained under pressure and where distillation of the lighter products from the residual oil takes place, removing the vapors therefrom for condensation of the heavier constituents under superatmospheric pressure into a liquid condensate, removing the vaporized lighter constituents and compelling the positive forcible return of condensate unmixed with residual oil through the heating coil by maintained mechanically applied pressure and supplying charging stock continuously to the process.

41. A process of oil conversion which comprises heating the oil under superatmospheric pressure in a heating coil to a cracking temperature in a single passage therethrough, delivering the heated oil into a cracking zone maintained under superatmospheric pressure, moderately heating the oil in said cracking zone to substantially maintain the cracking temperature and effect cracking of the oil therein, separating the cracked vapors from the residual oil and forming a condensate of the heavier constituents thereof, collecting the lighter constituents as a distillate, forcibly returning the condensate while in heated condition and under maintained mechanical pressure to the heating coil for further treatment, discharging the residual oil formed in the process, while preventing recirculation of residual oil through the heating coil, and continuously supplying charging stock to the process.

42. A process of cracking oil which comprises forcing a stream of charging oil under superatmospheric pressure through a heating coil where it is raised in single passage to a cracking temperature, delivering the heated oil into an enlarged zone where vaporization takes place under superatmospheric pressure, removing the evolved vapors and producing a condensate of the heavier constituents thereof, injecting a stream of condensate into the stream of charging oil by jet action, and pre-

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venting recirculation of residual oil formed in the process to the heating coil.

43. A process of oil conversion which comprises passing oil under superatmospheric pressure through a heating coil, raising the oil in single transit through said coil to a cracking temperature but removing the oil from the heating coil in a state of incipient cracking but before substantial cracking is effected, passing the heated oil free from residue into an enlarged cracking zone where it is maintained under superatmospheric pressure and at a cracking temperature for a sufficient time to effect material cracking thereof, separating the light cracked products from the residual oil by vaporization in said enlarged zone, discharging residual oil from the system, dephlegmating the vapors under superatmospheric pressure to separate out a condensate of the heavier constituents thereof, returning the hot condensate without release of pressure thereon by maintained forced mechanical pressure to the heating coil for retreatment, without permitting intermingling of residual oil with the oil in said heating coil and continuously supplying charging stock to the process.

44. A process of oil conversion which comprises forcing a stream of charging oil rapidly and under superatmospheric pressure once through a heating coil where it is raised to a cracking temperature but without substantial cracking therein, delivering the oil to a cracking zone where superatmospheric pressure and a cracking temperature is maintained and material cracking of the oil effected, discharging the residual oil formed in the process without permitting the return of any residual oil to the heating coil, producing a condensate of the heavier constituents of the vapors evolved in said cracking zone, and cyclically returning condensate while still hot under applied mechanical pressure to the heating coil for retreatment in said coil and said cracking zone in commingled relation with the charging stream.

In witness whereof I have hereunto set my hand this 2d day of April 1923.

OTTO BEHIMER.

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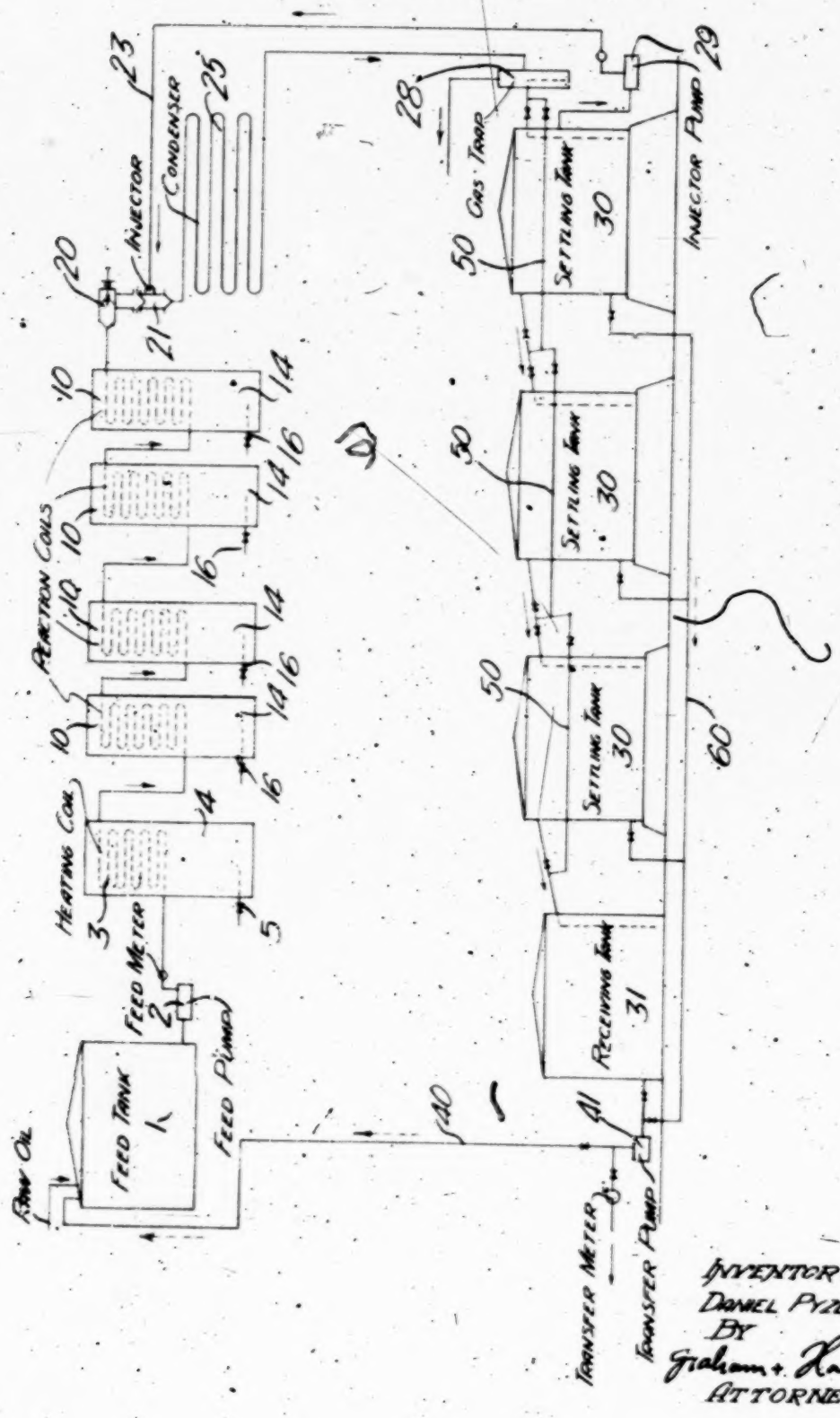
Dec. 13, 1932. D. PYZEL 1,891,218

CRACKING PROCESS FOR HYDROCARBON OILS

Filed July 24, 1922



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Patented Dec. 13, 1932

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UNITED STATES PATENT OFFICE

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CRACKING PROCESS FOR HYDROCARBON OILS

Application filed July 24, 1922. Serial No. 576,928.

My invention relates to the art of cracking hydrocarbon oils. It is a well known fact that many of the natural petroleum oils and their derivatives may have the molecular structure materially modified by subjecting them simultaneously to heat and pressure, this operation being commonly termed cracking. The cracking reaction changes the molecular structure of certain portions of the oil producing oils that contain a smaller number of carbon atoms per molecule than the original oil. Such oils are lighter, more volatile, and commercially more valuable than the original product. A rearrrangement of the molecule may be accomplished by adding hydrogen but in the ordinary cracking process it is accomplished by converting the oil into a lighter portion having a smaller number of carbon atoms per molecule, and a heavier portion having a much larger number of carbon atoms per molecule than the original oil. The heavier portion may be free carbon or it may be a tar or other substance containing a considerable proportion of carbon. All such substances whether free carbon or semi-solid carbonaceous substances, having a large proportion of carbon are hereinafter referred to as carbon.

Many petroleum oils, (and by petroleum oils, as used herein, I mean natural petroleum oils or their derivatives) when subjected to heat readily break up to set free carbon and produce an oil having a lower carbon content. The actual breaking up and rearrangement of the oil requires some time, however, so that it is not only necessary to raise the oil to a cracking temperature, but it is also necessary to maintain the oil at or near that temperature for a sufficient time to allow the cracking reaction to take place. It is also necessary, in the case of many oils, to maintain the oil under pressure during the entire time of the cracking reaction.

The prior art

The above facts are generally recognized among those skilled in the art and many processes have been devised for cracking oils. These processes have been carried on, for example, in two general types of apparatus, namely:

(A) Stills of large volume in which the oil is heated under pressure. In devices of this character the still may be first charged with oil and as the reaction progresses fresh oil may be run into the still, the lighter cracked products being taken off as vapor until the amount of carbon in the oil becomes so high that the carbon commences to deposit on the walls and particularly on the heated surfaces of the still. This is often disastrous to the still as these deposits have a high heat insulating value and as soon as deposition starts there is a decided tendency for the walls of the still under the deposits to overheat and to buckle or even blow out under the pressure necessary for the reaction. It is therefore necessary to use such processes largely on oils, which do not produce large amounts of carbon upon being cracked and it is also necessary not to carry the concentration of carbon in the still too high.

(B) Apparatus in which a considerable portion or all the heating is done in tubes the oil passing through these tubes and being delivered into large reaction chambers in which the cracking reaction takes place and in which carbon is deposited. The capacity of the reaction chamber to receive the deposited carbon limits the amount of oil that can be run through, it being common practice to run until the reaction chamber becomes so full of carbon that it is necessary to shut down and clean it out.

In both forms of apparatus, it is common practice to provide either a large still or a large reaction chamber which is operated under pressure and in which the carbon accumulates as the cracked products are distilled off therefrom. In both types of apparatus the carbon increases until it is necessary to shut down and clean it out, the amount of the oil that it is possible to run at one batch being limited to the capacity of the still or reaction chamber to safely contain the carbon. Since the apparatus may be run at temperatures as high as 900 degrees Fahr. it is uneconomical to shut down and thoroughly cool it for cleaning and the cleaning operation is both expen-

sive and troublesome. Moreover the manufacture of large stills or reaction chambers having a diameter of from six to ten feet capable of withstanding considerable pressures is both difficult and expensive and these big stills or reaction chambers containing oil under high temperatures and pressures form a very serious property and life hazard. Moreover the operation of both types of apparatus requires a very high degree of technical supervision since in the operation of both types there is a danger point in carbon concentration beyond which the operation cannot be safely carried.

Objects of invention

The object of my invention is to provide an apparatus for, and process of, cracking petroleum oils which may be operated continuously over long periods under high temperatures and pressures and in treating oils which produce a large proportion of carbon.

A further object of the invention is to provide a means for preventing depositions of carbon in those portions of the apparatus subjected to heat and pressure.

Further objects and advantages will be made evident hereinafter.

Description and method of operation

Referring to the drawing which is diagrammatic I employ a feed tank 1 from which the oil to be treated is taken by a feed pump 2 and delivered into a heating coil 3. This coil consists of a plurality of tubes contained in a heating furnace 4 which is heated by any suitable means such as an oil or gas burner 5. The oil in passing through the coil 3 is heated by the products of combustion in furnace 4 about the coil 3 to cracking temperature or to a temperature quite close to such a cracking temperature. The oil passes through the coil 3 at such a velocity that there is very little tendency to deposit carbon therein.

The oil at or near the cracking temperature is passed from the coil 3 into and through a series of reaction coils 10. These coils consist of tubes carried in reaction furnaces 14 which are heated by any suitable means such as an oil or gas burner 16. The oil in the reaction coils 10 is held at or near the cracking temperature during its passage therethrough by means of the products of combustion inside the furnaces 14. The cubical contents of the reaction coils and the rate of flow of the oil therethrough are made such that the oil is held at a cracking temperature for a sufficiently long period to effect an economical cracking thereof. At the same time the pressure established by the pump 2 is maintained in the heating coil 3 and the reaction coils 10, this pressure being sufficient to prevent complete vaporization of the oil in the heating and reaction coils, thus keeping the reaction within the limits of the two phase (liquid and vapor) reaction. The oil is delivered from the reaction coils 10 through a valve 20. After passing through the valve 20 the heated oil is delivered through a central jet into an injector 21, the space around this central jet in the injector being supplied with cold oil through a pipe 26. The pressure is reduced by the valve 20 and the injector 21 to at or near atmospheric pressure. The cold oil mixing immediately with the heated products delivered from the valve 20 forms a mixture which is at a very much lower temperature than the cracking temperature in the heating and reaction coils and this temperature is further reduced by passing the mixture through a condenser 25. The condenser reduces the mixture to temperatures not much in excess of atmospheric.

The cooled mixture is then passed through a gas trap or separator 28 and into the first of a series of settling tanks 30, passing successively through these tanks and into a receiving tank 31. The cooling oil delivered to the pipe 23 is taken from one of the settling tanks 30 and delivered under some pressure to the injector 21 by means of a pump 29. The gas from the gas trap 28 may be used for fuel in the heating and reaction furnaces.

In the settling tanks 30 the carbon largely settles out of the oil and the oil may be finally taken from the receiving tank 31 and fractionated in any of the various and well known manners. This oil consists of a mixture which is materially lower in carbon and commercially much more valuable than the oil originally delivered to the feed tank 1.

In starting up the apparatus to prevent carbon deposition, it is desirable to circulate the oil through a circulation line 40 from the receiving tank to the feed tank which may be accomplished by a transfer pump 41. Each of the settling tanks 30 is provided with a by-pass pipe 50 so that it may be cut out of service for the purpose of cleaning out the carbon that accumulates therein. Since these tanks are under atmospheric pressure and substantially under atmospheric temperatures, they may be of very cheap construction and of large capacity. A drain pipe 60 allows any tank 30 to be drained at will.

Advantages of process

It will be seen that the oil is first quickly heated to a cracking temperature in the heating coil 3 and then maintained at or near that temperature in the reaction coils 10. The necessary heat to maintain this temperature and supply heat for the cracking reaction and the vaporization of light products is supplied through the walls of the reaction coils 10 from the burners 16. The proportion of the coils 10 is such that the oil moves therethrough with sufficient rapidity to prevent deposition of carbon therein but sufficient time

is allowed to allow the cracking reaction to take place. Since the coils 10 are of small diameter their effective heating surface is large. For example, if the reaction coils are three inches in diameter their effective surface will be twenty four times as great as the effective surface of a cylindrical still six feet in diameter and of the same cubical contents as the reaction coils 10. This allows the same amount of heat transfer as in the case of the large still with one twenty-fourth the difference in temperature between the gases of combustion outside the tubes and the oil inside the tubes and this low temperature of the hot gases inside the reaction furnaces 14 prevents overheating of the tubes and consequent deposition and baking of carbon thereon. Also the movement of the oil in the tubes is sufficiently rapid to further greatly increase the efficiency of heat transfer and considerably increase this ratio of twenty-four to one. Moreover the first cost and cost of maintenance and repair of small tubes is greatly less than that of large stills, and the factors of safety of the tubes can be economically made much higher than is possible in large stills or reaction chambers.

It will be further seen that the cracking pressure is maintained throughout the heating and cracking coils and that it is released in the valve 20 and the injector 21. A release in pressure would naturally result in an immediate vaporization of the lighter and more volatile portions of the oil. If this vaporization were allowed to take place freely, the cracked fractions would immediately be set free as vapor and there would immediately be a strong tendency of the carbon to deposit on any surface to which it would cling. This would be due in part to the fact that the carbon and particularly the heavy tarry hydrocarbons are held more or less in solution in the more volatile portions of the mixture and the vaporization of these volatiles would be accompanied by a corresponding deposition of the dissolved heavy tars and carbons. This deposition is prevented by the immediate injection and mixing of cold oil with the mixture of hot products leaving the reaction coil. This injection not only cools the mixture and thus prevents vaporization of the more volatile oils contained therein but it also supplies additional volatiles from the settling tanks which volatiles have been in a measure freed from their solids and semi-solids by settling.

It will further be seen that although my process does not and cannot prevent the formation of carbon, it prevents the deposition of this carbon in those portions of the apparatus under pressure and in which the oil is in contact with heated surfaces. This carbon largely settles out in the settling tanks 30 which are not under pressure and which can therefore be readily cleaned being bypassed so that the process need not be interrupted during the cleaning operation.

I claim as my invention:

1. A process for the conversion of hydrocarbon oils consisting in heating a stream of oil to a cracking temperature, in passing such heated oil through a reacting zone where the oil is maintained under a superatmospheric pressure and where a substantial portion of the oil remains in liquid phase, in continuously introducing said oil to a zone of lower pressure in such a manner as would permit vaporization of said oil, and in checking such vaporization by introducing regulated quantities of a cooling medium to said zone of reduced pressure.

2. An oil conversion process consisting in heating a stream of hydrocarbon oil in a coil to a cracking temperature above the boiling point of the constituents thereof, in passing such oil through a reacting zone where cracking occurs, in maintaining a superatmospheric pressure on the oil in said heating coil and said reacting zone to prevent vaporization of a substantial portion of said oil, in continuously introducing said heated oil to a zone of reduced pressure, and in substantially checking the vaporization of said heated oil by the regulated introduction of a cooler mass of hydrocarbon oil to said zone of reduced pressure.

3. A continuous process for the conversion of hydrocarbon oil, consisting in advancing a stream of oil through a heating zone to be heated to a cracking temperature, in passing said heated oil through a reaction zone where conversion occurs, in maintaining a superatmospheric pressure on the oil stream and on the oil in such reaction zone to prevent vaporization of a substantial quantity of said oil, in introducing said heated oil to a zone of lower pressure in such a manner as would permit vaporization of the chemical constituents thereof, and in substantially checking such vaporization of the heated oil by the introduction of a regulated quantity of cooler oil to said zone of reduced pressure.

In testimony whereof, I have hereunto set my hand at San Francisco, California, this 14th day of July, 1922.

DANIEL PYZEL.

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Dec. 5, 1933. L. C. HUFF 1,937,959

PROCESS OF CRACKING HYDROCARBON OILS

Filed Feb. 19, 1930 2 Sheets-Sheet 1

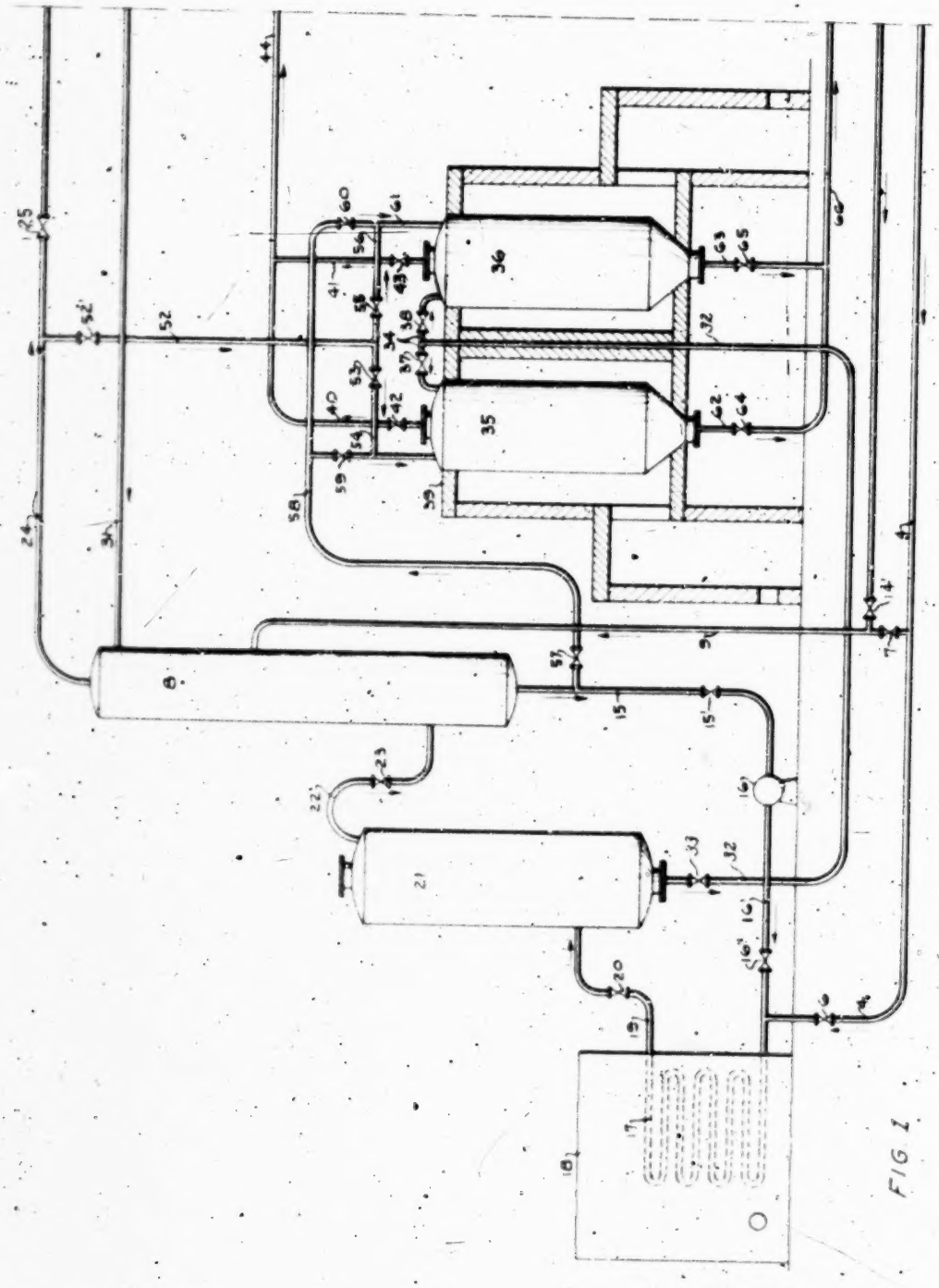

FIG 1

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Dec. 5, 1933. L. C. HUFF 1,937,959

PROCESS OF CRACKING HYDROCARBON OILS

Filed Feb. 19, 1930 2 Sheets-Sheet 2

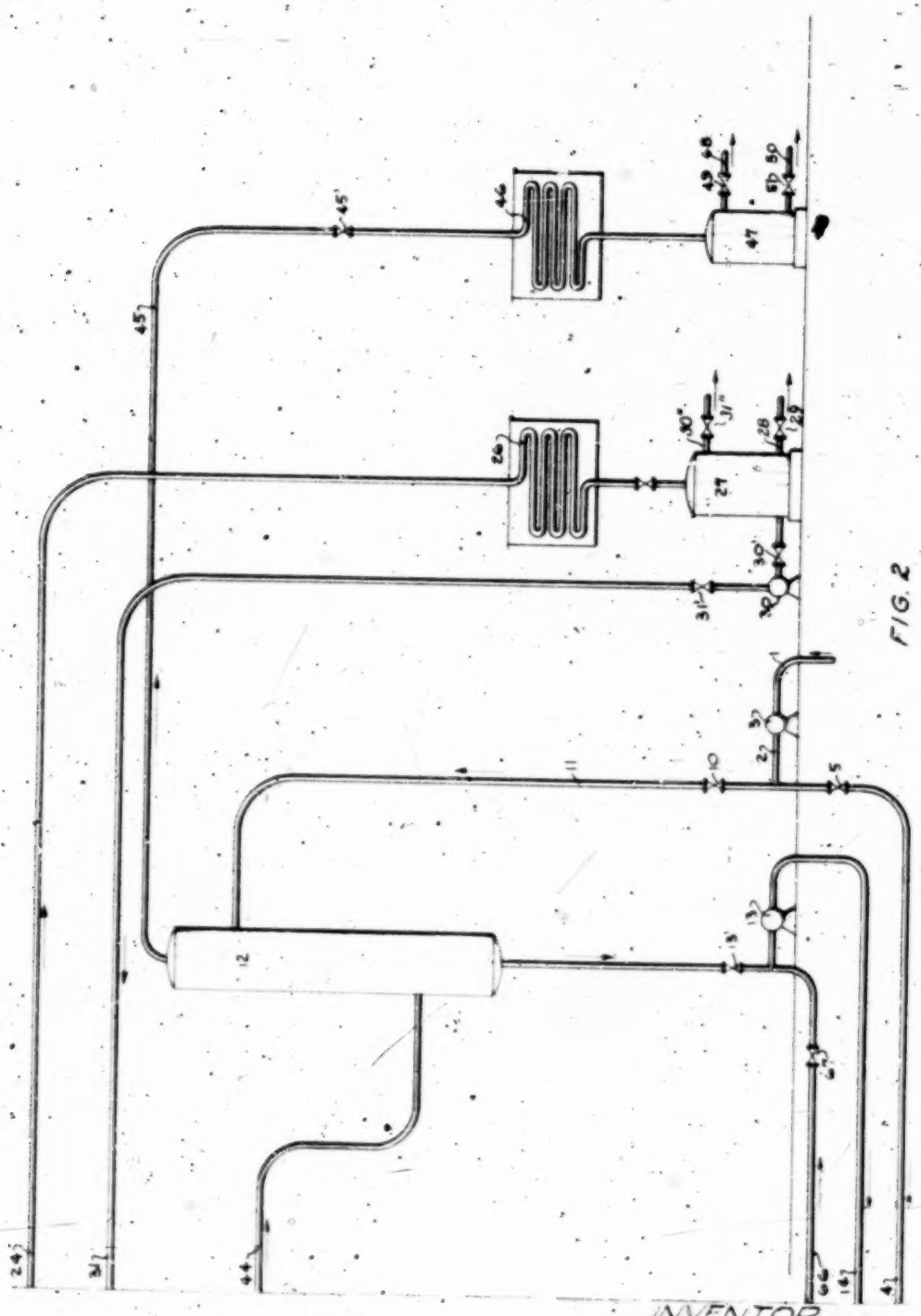

FIG. 2

INVENTOR
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BY Frank L. Belknap
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Patented Dec. 5, 1933

1,937,959
3515

UNITED STATES PATENT OFFICE

1,937,959

PROCESS OF CRACKING HYDROCARBON OILS

Lyman C. Huff, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill., a corporation of South Dakota

Application February 19, 1930. Serial No. 429,475

3 Claims. (Cl. 196—49)

This invention relates to the treatment of hydrocarbon oils and relates more particularly to a continuous process for the regulated thermal decomposition or cracking of petroleum products, which can be regulated to produce the maximum yields of low boiling products suitable for motor fuel and other products resulting from cracking.

In the operation of modern cracking processes, the period of operation relative to the shut-down or so-called clean-out period is determined not only by the kind of oil being processed but also by the mode of operation. Depending upon local or general market conditions, the cracking process may be operated to produce motor fuel as its principal product with no other products but coke and gas and possibly an intermediate cut corresponding to gas oil. With some kinds of oil this kind of operation is not desirable and in addition the local market condition may make it necessary to produce a marketable fuel oil as one of the major products with the minimum of coke production.

The process which I am about to describe is adapted to operate upon the non-residuum basis, wherein the major products from the processing of relatively high boiling hydrocarbons are coke and gasoline, with the greatest economy in operating cycle and low investment cost in equipment, while on the other hand my process permits a more continuous operation from the viewpoint of operating cycle when producing fuel oil as one of the major products in addition to gasoline.

When operating the process on the non-residuum basis it can be adapted to cause the coke to be deposited in a low pressure zone thereby reducing equipment cost. When operating on a fuel oil basis particularly by the so-called flashing type of operation wherein the hot non-vaporized liquid from the reaction chamber is permitted to undergo substantial vaporization in a low pressure zone, means are provided for the use of alternate flash distillation or evaporation chambers whereby the operating cycle is considerably lengthened, thus reducing operating costs. The benefits to be obtained by the latter mode of operation are the production of a clean liquid residue highly suitable for use as fuel and containing unobjectionable amounts of suspended pitchy and carbonaceous particles referred to as B. S.

In order to make clear the operation of the process of my invention, I will refer to the drawings, Figures 1 and 2. The raw charging oil, consisting for example of a petroleum fraction higher in boiling range than gasoline, is pumped from line 1 by pump 3 through line 2 and may then take one of several courses or paths through the system. The raw oil may be fed direct to the heating tubes through line 4, controlled by valves 5 and 6, (valves 7 and 10 remaining closed) or by opening valve 7 the oil may be fed direct into the dephlegmator 8 wherein it undergoes heat exchange with the vapors rising in the dephlegmator and is thus preheated before passing into the heating tubes. Preferably, however, the raw charging oil passes through line 2 and valve 10 in line 11 into the secondary or flash dephlegmator 12, being heated by the vapors arising therein.

The raw charging oil together with reflux formed in the secondary or flash dephlegmator 12 passes through valve 13' is picked up by pump 13 and pumped through line 14, valve 14' and line 9 into primary dephlegmator 8 where together with the reflux formed therein it passes through line 15 and valve 15' and the combined feed is forced by hot oil pump 16 through line 16', valve 16'' and the heating tubes 17. The latter are located in a suitable furnace setting 18. The combined oil feed heated to the conversion temperature is discharged through line 19, controlled by valve 20' into reaction chamber 21 where the reaction is completed. The vapors arising in reaction chamber 21 pass through line 22, controlled by valve 23, into primary dephlegmator 8. As previously mentioned the reflux resulting from condensation of the heavier components of the vapors entering dephlegmator 8 is returned together with the raw charging oil to the heating tubes.

The vapors leaving dephlegmator 8 and containing the low boiling product of the process pass through line 24 and valve 25 into cooler and condensing coil 26; the liquid resulting therefrom passes into receiver 27 and may be passed through line 28, controlled by valve 29 to storage. A portion of the low boiling product of the process may be returned by means of pump 30 through valve 30' line 21 and valve 31' to dephlegmator 8 to assist in cooling and regulating the temperature in the dephlegmator and in the fractionation of the vapors therein. The uncondensable gas is removed from the receiver 27 through line 30'', controlled by valve 31''. The gas may be used as fuel for the system, or may be scrubbed to remove the low boiling liquids contained therein and/or used for other purposes.

The non-vaporized residue from reaction chamber 21 passes through line 32, controlled by valve 33, into branch lines 34, wherefrom it may be passed into either one of alternate chambers 35

and 36, the flow into the chambers being controlled by valves 37 and 38.

Chambers 35 and 36, which will be referred to as flash chambers, are at a substantially lower pressure than the reaction chamber, which causes the non-vaporized residue leaving the reaction chamber to undergo substantial vaporization when introduced into the flash chamber owing to the so-called latent heat contained in the residue. The degree of vaporization of the residue passing from reaction chamber 21 into the flash chambers 35 or 36 depends upon the temperature, the difference in pressure between the reaction chamber and the flash chambers, and the average boiling point of the material sent into the flash chambers.

The operating conditions may be controlled to permit approximately forty percent by volume of vaporization when producing a fuel oil, or by increasing the temperature of the oil leaving the heating coil and consequently the temperature of the reaction chamber, complete vaporization to a coke residue may occur in the flash chambers 35 and 36.

To further assist control of the degree of vaporization flash chambers 35 and 36 may be located in a furnace setting 39 which may be heated by independent firing or through which the flue gases from furnace setting 18 may be caused to circulate, by means not shown, around the flash chambers.

The vapors arising from the flash chambers pass through lines 40 and 41, controlled by valves 42 and 43 into line 44 and from there into flash dephlegmator 12. The incoming raw oil causes substantially complete condensation of the vapors in flash dephlegmator 12 or, if necessary, may be augmented by the cooling effect of portions of the light condensate from this dephlegmating zone recirculated thereto, by well known means not shown. The combined preheated raw oil and reflux condensate is pumped by means of pump 13 through line 14 into dephlegmator 8 and subsequently into the heating tubes as heretofore described. The vapors leaving the flash dephlegmator 12, consisting of a relatively small percentage of low-boiling material, pass through line 45, valve 45' and cooler and condenser 46 to be collected into receiver 47. A small proportion of uncondensable gas is removed through line 48, controlled by valve 49. The collected liquid is removed through line 50, controlled by valve 51.

One of the special features of the present invention is the alternate use of flash chambers 35 and 36 in the operation of the process. The advantage of such alternate use is primarily to lengthen the operating cycle and in general render the operation of the process more economical. This feature of the invention may be adapted to either the non-residuum mode of operation or the operation wherein a liquid fuel oil residue is produced. It may also be adapted to an intermediate operation wherein a product suitable for asphalt may be produced. As the particular mode of operation depends primarily upon operating conditions, the principle of alternation applies equally to all modes of operation.

In the non-residuum type of operation the non-vaporized residue leaves reaction chamber 21 through line 32, controlled by valve 33 through line 34 into either one of the chambers, for example 35, controlled by valve 37. The temperature maintained upon the products in the transfer line 19 and the pressure within reaction chamber 21 is such that upon the discharge of the residue into chamber 35 sufficient vaporization occurs to reduce the liquid residue to coke. By externally heating chamber 35 by means already described the other operating conditions may be modified accordingly, thus giving a wide degree of flexibility. Still another of the many suitable methods of increasing the volatilization of the residual liquid to cause its reduction to coke consists in injecting into the flash chambers 35 and 36 a portion of the vapors along with the residue by withdrawing same from reaction chamber 21, through line 32 controlled by valve 33 and also separately by means not shown in the drawings. This method not only causes increased evaporation by the addition of heat, but the introduction of the light vapors will also cause a substantial lowering of the average boiling point of the material in the flash chambers.

In making liquid residue in chamber 35 the temperature of the oil leaving the heating coil 17 and the pressure on reaction chamber 21 may be reduced accordingly and usually in this case no external heat or other auxiliary vaporizing means need be applied to the flash chamber. In making asphalt conditions intermediate between those already described may be used.

It is quite obvious in the non-residuum mode of operation that there is a great advantage in depositing the coke in a zone external to the reaction zone or in a low pressure zone as equipment costs are thereby decreased and the operating cycle is greatly increased.

In the present invention I provide means for switching or alternating the flash chambers when either one of them is filled with coke—for example, in the operation just described when chamber 35 is filled with coke the stream of non-vaporized residue from reaction chamber 21 is diverted into flash chamber 36 after first preparing the chamber by one of several means which will be hereinafter described. Likewise, in the residuum type of operation or when making asphalt conditions arise either due to the operation or to the kind of oil being processed whereby it becomes greatly advantageous to switch or alternate the chambers and my process permits this.

In alternating the flash chambers it is first desirable to remove the air from the chamber which is to be cut into the process operation. This is done preferably by displacing the air with liquid or vapors, for example, when chamber 35 is to be cut out and chamber 36 to be cut in or introduced into the system the latter may be filled with oil and heated by means of flue gas, the oil therein being gradually displaced by residue. Preferably, the oil used should be the flashed residue product of the process itself.

Another means of cutting in the alternate chamber is to introduce steam for some time to displace the air, gently warming the chamber by flue gases and then cutting in the stream of hot liquid from the reaction chamber. Still another means of accomplishing this purpose is to gradually displace the air by the introduction of vapors, for example, from the dephlegmator 8 through valve 52' and line 52, the vapors passing either through valve 53 and line 54, into flash chamber 35, or through valve 55 and line 56 into chamber 36. The reflux liquid or combined feed from dephlegmator 8 may also be directed into the flash chamber 35 by diverting it from line 15 through valve 57, line 58 and valve 59, or into flash chamber 36 through valve 60 and line 61. The unvaporized reflux may be drawn out

from the flash chambers through lines 62 and 63 through valves 64 and 65 and returned to the system through line 66 controlled by valve 67 and through pump 13 in the manner heretofore described.

Another method of purging the flash chambers of air before they are cut into the system may employ uncondensed gas from the same or a different process or other gas such as producer or natural gas. This gas may be introduced into the chambers by providing the proper connecting lines, not shown on the drawings, and may be so introduced either cold or, preferably, in a preheated state.

Other means of preparing the flash chamber either with regard to evacuation of the air or heating of the chambers before switching the stream of hot residuum from reaction chamber 21 are available, but those described are sufficient to show the operation. Coke if formed therein is removed from flash chambers by a cable or similar device previously placed within the chambers.

As examples of the results obtained by my process, a 24 A. P. I. gravity topped Mid-Continent crude was treated at a transfer temperature, i. e. the temperature leaving the heating element or at 19, of approximately 900° F., and the temperature in the reaction chamber was approximately 835° F.; the temperature in the top of the primary dephlegmator 8 was approximately 500° F. and that of the combined feed was approximately 750° F. The pressure upon the heating coil 17, the reaction chamber 21, and primary dephlegmator 8 was approximately 200 pounds per square inch. The comunication between the receiver 27 and dephlegmator 8 was open and free so that the difference in pressure between these two elements was due only to the normal pressure drop through the condenser and connecting lines.

The amount of coke made was approximately one-quarter pound per barrel.

The pressure in flash chamber 35 and flash dephlegmator 12 was approximately 30 pounds per square inch. The temperature in flash chamber 35 was approximately 675° F. During the operation chamber 36 was cut in to prolong the run.

The yield of products under these operating conditions was approximately 50 percent motor fuel with an initial boiling point of approximately 100° F. and an end point of approximately 437° F.; 35 percent of flashed residual fuel oil having a viscosity of approximately 300 Furol seconds at 122° F.; and approximately 10 percent of pressure-distillate bottoms of approximately 32 A. P. I. gravity; and about 5 percent coke, gas and loss.

When operating to make asphalt in the flash chambers 35 and 36 using the alternate method of operation with these flash chambers, a yield of approximately 55 percent motor fuel was obtained corresponding in boiling range to that obtained in the former operation about 20 percent of asphalt corresponding in specifications to steam-refined paving asphalt, about 15 percent of pressure-distillate bottoms of approximately 32 A. P. I. gravity, and about 10 percent coke, gas and loss. The amount of coke made was approximately 1½ pounds per barrel.

When operating on the non-residuum basis making only coke, distillate and gas, approximately 63 percent of motor fuel was made equivalent in boiling range to that made in the first operation, approximately 10 percent of pressure-distillate bottoms, about 27 percent of coke, gas and loss. The amount of coke made was approximately 55 pounds per barrel and the amount of gas approximately 675 cubic feet per barrel of oil charged.

Compared with normal operation wherein the alternate flash chambers are not used, the running time on non-residuum operation would be approximately twice as long as that utilizing a single reaction chamber of equivalent capacity to one of the flash chambers. It is quite obvious that in a continuous operation the coke produced, which is normally the limitation on the operating cycle, becomes a secondary factor in the operation of my process. It is also obvious that I may use two or more flash chambers according to the concepts of my process.

While the above examples are illustrative of my process, I do not wish to be limited thereby in view of the broad scope of the invention.

I claim as my invention:

1. In an oil cracking process of the character wherein vapors produced in the process are dephlegmated in a dephlegmating zone and carbon precipitated from the cracked liquid oil in enlarged chambers which are alternately cut in and out of the cracking system for carbon deposition therein and cleaning; the method of preconditioning the chambers prior to being cut into the system and after cleaning which comprises preheating charging oil for the cracking process in said dephlegmating zone by heat exchange with the vapors therein, introducing charging oil thus preheated to the chamber to be preconditioned, and then supplying such charging oil to the cracking system for cracking treatment therein.

2. In an oil cracking process of the character wherein vapors produced in the process are dephlegmated in a dephlegmating zone and carbon precipitated from the cracked liquid oil in enlarged chambers which are alternately cut in and out of the cracking system for carbon deposition therein and cleaning; the method of preconditioning the chambers prior to being cut into the system and after cleaning which comprises preheating charging oil for the cracking process by direct contact with the vapors in said dephlegmating zone, passing at least a portion of the resultant mixture of preheated charging oil and reflux condensate into the chamber to be preconditioned and then supplying the mixture to the cracking system for cracking treatment therein.

3. In an oil cracking process of the character wherein vapors produced in the process are dephlegmated in a dephlegmating zone and carbon precipitated from the cracked liquid oil in enlarged chambers which are alternately cut in and out of the cracking system for carbon deposition therein and cleaning; the method of preconditioning the chambers prior to being cut into the system and after cleaning which comprises introducing thereinto reflux condensate formed in said dephlegmating zone, withdrawing the reflux condensate from the cut-out chamber being preconditioned and then returning the same to the cracking system.

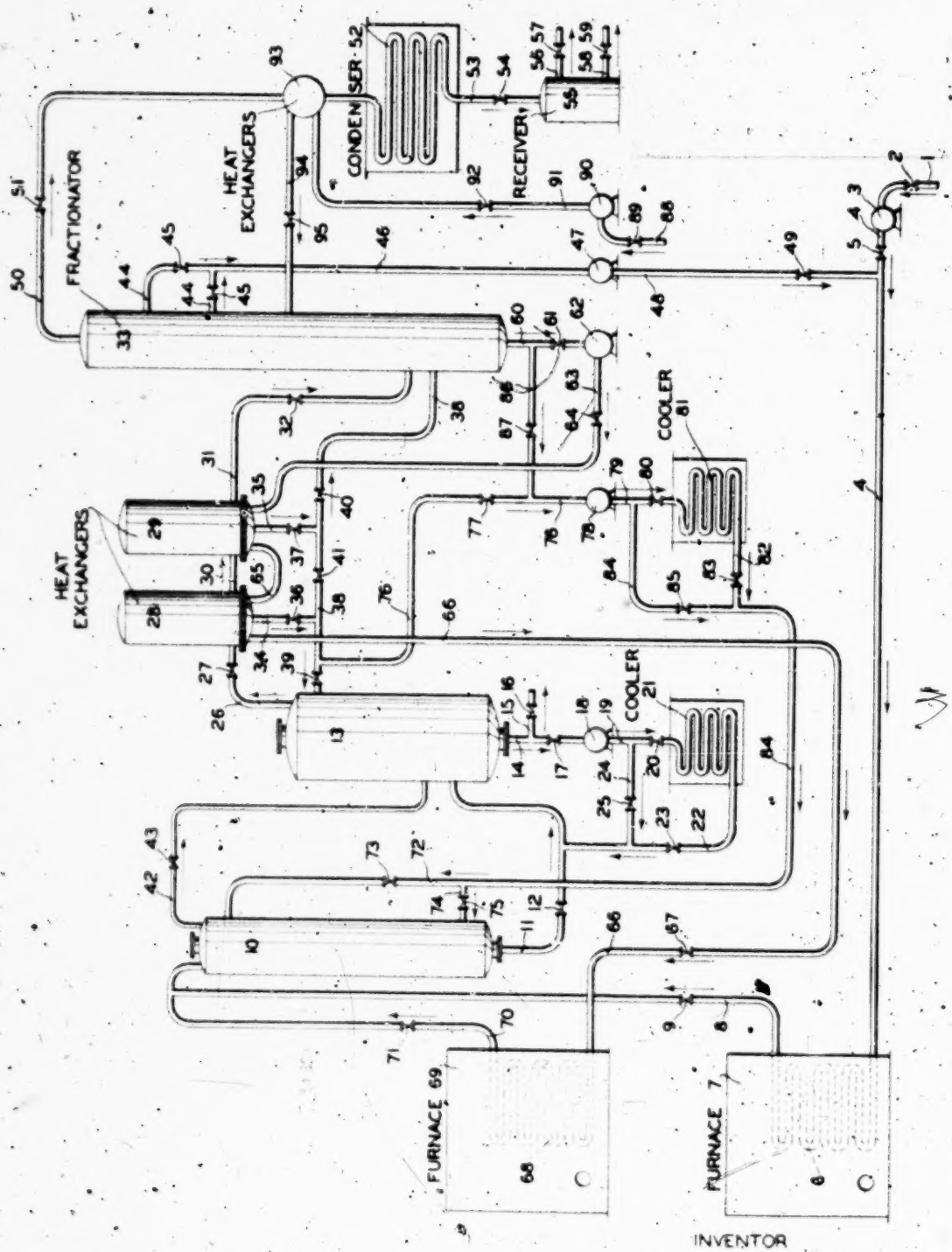
LYMAN C. HUFF.

3520

May 5, 1936. L. C. HUFF 2,039,797

HYDROCARBON OIL CONVERSION

Filed Jan. 14, 1933



INVENTOR

LYMAN C. HUFF

BY Frank L. Belknap

ATTORNEY

UNITED STATES PATENT OFFICE

2,039,797

HYDROCARBON OIL CONVERSION

Lyman C. Huff, Chicago, Ill., assignor to Universal Oil Products Company, Chicago, Ill., a corporation of Delaware

Application January 14, 1933, Serial No. 651,741

6 Claims. (Cl. 196—48)

This invention particularly refers to an improved process and apparatus for the simultaneous conversion of different hydrocarbon oil charging stocks wherein the different charging stocks and different selected intermediate conversion products of the process are each subjected to independently controlled conversion conditions of elevated temperature and superatmospheric pressure regulated to secure the production of high yields of desirable light hydrocarbons such as motor fuel of high anti-knock value.

A specific embodiment of the present invention may comprise subjecting a relatively low boiling hydrocarbon oil charging stock to conversion temperature at superatmospheric pressure in a heating coil, introducing the heated oil into an enlarged reaction chamber, also maintained at superatmospheric pressure, withdrawing both vaporous and liquid conversion products from the reaction chamber to a reduced pressure vaporizing chamber wherein further vaporization of liquid conversion products and separation of the residual liquid from the vaporous products of the process is accomplished, withdrawing residual liquid from the vaporizing chamber and returning a regulated portion thereof to commingle with and assist cooling of the products passing from the reaction chamber to the vaporizing chamber, withdrawing vaporous conversion products from the vaporizing chamber and subjecting them to indirect contact and heat exchange with cooler oil from within the system whereby a portion of their high-boiling components are condensed, subjecting the remaining vaporous conversion products to fractionation, supplying condensate resulting from said heat exchange in regulated amounts either to the vaporizing chamber and/or to the fractionator and/or to the reaction chamber, arbitrarily separating the reflux condensate formed by fractionation of the vaporous conversion products into low boiling and high boiling fractions, simultaneously supplying to the fractionator, preferably in preheated state, another hydrocarbon oil charging stock of different characteristics than the first mentioned charging stock whereby it is subjected to the same separation in the fractionator as that afforded the vaporous conversion products of the process, subjecting fractionated vapors of the desired end-boiling point to condensation, collecting the resulting distillate and gas, returning said low-boiling fraction of the reflux condensate, together with any components of the second mentioned charging stock of similar boiling range, to the heating coil for conversion with the first mentioned charging stock, passing said high boiling fraction of the reflux condensate, together with any fractions of the second mentioned charging stock of corresponding initial boiling point, in indirect contact and heat exchange with the vaporous conversion products from the vaporizing chamber, then subjecting this material to independently controlled conversion temperature and superatmospheric pressure in a separate heating coil and introducing the heated oil from said separate heating coil into the reaction chamber.

The first mentioned charging stock, which may, for the sake of convenience, be termed "primary charging stock," preferably comprises a hydrocarbon oil distillate such as light gas oil, kerosene distillate, naphtha, pressure distillate bottoms, straight-run gasoline or other motor fuel of inferior anti-knock value or fractions or mixtures of such materials. The last mentioned or secondary charging stock, which is supplied to the fractionator of the system, may comprise any desired hydrocarbon oil ranging from naphtha or other light distillates through the various crude oil fractions to residual or fuel oil and specifically including oils such as crude petroleum, topped crudes and the like, as well as pressure distillate, pressure distillate bottoms or other final or intermediate products of conversion. Any material boiling within the range of the desired final light product of the process contained within the secondary charging stock are vaporized within the fractionator and recovered with the motor fuel conversion product of the process. Any materials contained within the secondary charging stock boiling within the range or having cracking characteristics similar to the primary charging stock are preferably withdrawn from the fractionator, together with selected low-boiling fractions of the reflux condensate of corresponding boiling range and subjected to conversion, together with the primary charging stock. Any components of the secondary charging stock of higher boiling nature than the material returned from the fractionator to conversion with the primary charging stock collect with the high-boiling fractions of the reflux condensate and are subjected therewith to independently controlled conversion conditions in a separate heating coil. Thus, it will be apparent that the process of the present invention possesses a wide flexibility with respect to the type of oil which may be em-

ployed as secondary charging stock, inherently providing for optimum treatment of the various fractions of virtually any type of oil.

The accompanying diagrammatic drawing illustrates one specific form of cracking apparatus embodying the features of the present invention and the cooperative nature of its various features will be more apparent with reference to the following description of the drawing which includes a more detailed description of the operation of the process as it may be practised in the apparatus shown.

Primary charging stock for the cracking operation which may comprise, for example, straight-run gasoline or other motor fuel of low-anti-knock value, naphtha, kerosene distillate, pressure distillate bottoms, gas oil, light gravity crude or similar hydrocarbon oil is supplied through line 1 and valve 2 to pump 3 by means of which it is fed through line 4 and valve 5 to heating coil 6. The charging stock may, of course, be preheated in any well known manner (not shown) prior to its introduction into the heating coil.

The oil supplied to heating coil 6 is subjected therein to the desired conversion temperature, preferably at substantial superatmospheric pressure, by means of heat supplied from a furnace 7 of any suitable form. The heated oil is discharged from the heating coil through line 8 and valve 9 into reaction chamber 10.

Chamber 10 is also preferably maintained at a substantial superatmospheric pressure and, although not illustrated in the drawing, is preferably well insulated to prevent the excessive loss of heat therefrom by radiation so that conversion of the products introduced into the reaction chamber, and particularly their vaporous components, may continue in this zone. In the case here illustrated, both vaporous and liquid conversion products are withdrawn in commingled state from the lower portion of the reaction chamber, passing through line 11 and valve 12 into vaporizing chamber 13. When desired, in order to prevent segregation of vapors and gases in chamber 10 and the formation of a gas pocket in the upper part of the chamber a portion of the vaporous conversion products may be separately withdrawn from the upper portion of this zone passing through line 42 and valve 43 into chamber 13.

Chamber 13 is preferably maintained at a substantially reduced pressure relative to that employed in chamber 10, by means of which further vaporization of the liquid conversion products introduced into this zone is accomplished. The vaporous and residual conversion products of the process are separated in chamber 13 and the residual liquid remaining unvaporized in this zone is withdrawn therefrom through line 14 and may pass, all or in part, to storage or to any desired further treatment through line 15 and valve 16.

When desired, in order to cool the products passing from chamber 10 through line 11 to chamber 13 further than the cooling accomplished by the pressure reduction in passing through valve 12, so as to prevent the formation and deposition of coke or heavy pitch-like material in this line and to assist in regulating the quality of the residual product produced in chamber 13, a suitable cooling oil from within or from outside the system may be commingled with the products passing through line 11. The drawing illustrates one specific method and means of accomplishing this object whereby a portion of the residual oil withdrawn from chamber 13 passes through valve 17, in line 14, to pump 18 by means of which it is fed through line 19 and valve 20 and through cooler 21 from which it passes through line 22 and valve 23 into line 11. When desired, all or any portion of the residual oil thus recirculated to line 11 may by-pass cooler 21 by means of line 24, controlled by valve 25.

Vaporous products of the process are withdrawn from chamber 13 through line 26 and valve 27 and may pass through heat exchangers 28 and 29, a connecting vapor line 30 being interposed between the heat exchangers, passing therefrom through line 31 and valve 32 to fractionation in fractionator 33.

The vaporous conversion products of the process are partially cooled in heat exchangers 28 and 29 by indirect contact with a suitable cooling medium, preferably comprising raw oil charging stock or intermediate conversion products of the process or mixtures of such materials, whereby the heat extracted from the vapors is recovered for a useful purpose and certain high-boiling fractions of the vapors, undesirable as recycled stock, are condensed therefrom. Condensate formed in heat exchangers 28 and 29 is withdrawn therefrom through line 34 and valves 35, respectively, controlled by the respective valves 36 and 37, passing into line 38 from which all or a portion of this material may be returned through valve 39 in this line into vaporizing chamber 13 or through valve 40, in line 38, into fractionator 33. A valve 41, in line 38, between the junction of this line with lines 34 and 35 permits separation of the condensates from heat exchangers 28 and 29 so that the somewhat heavier material from the first heat exchanger 28, may be turned to chamber 13, as described, while the somewhat lighter condensate from the second heat exchanger 29, passes to chamber 33. In this manner when substantially all of the objectionable heavy components of the vapors are condensed therefrom in heat exchanger 28, additional heat may be extracted from the vapors in heat exchanger 29, prior to their fractionation for the preheating, for example, of raw oil or recycled stock without decreasing the desirable recycled stock which, in this case, is returned from heat exchanger 29 to fractionator 33. It will be understood that it is within the scope of the invention to employ a single heat exchanger or any number of a plurality of such zones, dividing the condensate therefrom, when desired, into any number of separate streams of somewhat different boiling characteristics for treatment in the manners indicated.

Ordinarily, rough fractionating means such as suitable baffles (not shown) are located in the upper portion of vaporizing chamber 13 for the purpose of preventing heavy oil particles entrained in the vapors from passing to further treatment therewith. In such cases the condensate returned from heat exchanger 28 or from heat exchangers 28 and 29 to chamber 13 will serve as a refluxing medium, being introduced above the fractionating means and flowing downward thereover to assist cooling of the vapors and extraction of the entrained heavy oil particles.

The vaporous conversion products of the process supplied to fractionator 33, as described, are subjected to fractionation in this zone by well known means whereby their insufficiently converted components, boiling above the range of the desired final light distillate product of the process, are condensed as reflux condensate.

Fractionated vapors of the desired end-boiling point, representing the final light distillate product of the process and preferably of substantially

motor fuel boiling range, are withdrawn, together with uncondensable gas, from the upper portion of fractionator 33 through line 50 and valve 51 to be subjected to condensation and cooling in condenser 52, from which the resulting distillate and gas passes through line 53 and valve 54 to collection and separation in receiver 55. Uncondensable gas may be released from the receiver through line 56 and valve 57. The distillate may be withdrawn from receiver 55 through line 58 and valve 59 to storage or to any desired further treatment. When desired, a portion of the distillate collected in receiver 55 may be recirculated, by well known means (not shown) to the upper portion of fractionator 33 to assist fractionation of the vapors in this zone and to maintain the desired vapor outlet temperature from the fractionator.

As a special feature of the invention the reflux condensate formed in fractionator 33 is arbitrarily separated into low-boiling and high-boiling fractions. The low-boiling fractions of the reflux condensate are withdrawn as a side-stream from one or a plurality of suitable points in the fractionator, for example, through lines 44, controlled by valves 45, passing through line 46 to pump 47 by means of which this relatively low boiling oil, preferably within the boiling range or otherwise corresponding in cracking characteristics to the primary charging stock, is fed through line 48 and valve 49 into line 4, commingling therein with the primary charging stock and passing therewith to conversion in heating coil 6. It will be understood that well known means (not shown) may be provided, when desired, for subjecting the side-stream from fractionator 33 to reboiling, whereby it may be substantially freed of desirable light products within the boiling range of the overhead product from the fractionator.

Heavy fractions of the reflux condensate formed in fractionator 33, boiling above the desired end-boiling point of the selected fractions returned to heating coil 6 as described, collect within the lower portion of the fractionator, from which they are withdrawn through line 60 and valve 61 to pump 62, by means of which they are returned through line 63, valve 64, heat exchanger 29, line 65, heat exchanger 28, line 66 and valve 67 to heating coil 68 for further conversion. It will be understood that, when desired, all or any portion of this material may be diverted from either or both of the heat exchangers, by well known means (not shown).

The oil supplied to heating coil 68 is subjected therein to independently controlled conversion conditions of elevated temperature and superatmospheric pressure by means of heat supplied from a furnace 69 of any suitable form and the heated oil is discharged through line 70 and valve 71 into reaction chamber 10, commingling therein or prior to its introduction thereto with the heated oil from heating coil 6, and being subjected thereafter to the same treatment, in chamber 10 and in subsequent portions of the system, as that already described in connection with the heated oil from heating coil 6.

As another special feature of the invention a suitable oil or mixture of oils, preferably from within the system, may be introduced, at one or a plurality of desirable points, into reaction chamber 10, particularly for the purpose of cooling and/or diluting and increasing the volume of liquid traversing or withdrawn from this zone. Such an oil, introduced, for example, into the upper portion of chamber 10 through line 72 and valve 73, may be sprayed against the inner surface of the walls of the reaction chamber by any suitable spray device (not shown), to dilute, cool and increase the volume of liquid passing downward over the walls of the chamber in order to hasten its passage through and removal from this zone, thereby assisting in preventing the formation of coke on the walls of the chamber. In a similar manner oil introduced into the lower portion of the chamber through line 74 and valve 75 may commingle with the vaporous and liquid conversion products withdrawn through line 11, thereby increasing the volume of liquid passing through this line and increasing its velocity as well as cooling and diluting the products passing therethrough, in order to prevent the formation and deposition of coke or heavy pitch-like material in line 11.

The drawing illustrates a method and means of employing two specific intermediate products of the operation as cooling oil in chamber 10. One suitable material for this purpose comprises all or a portion of the condensate from heat exchanger 28 or from heat exchangers 28 and 29 which is withdrawn from line 38 through line 76 and valve 77 to pump 78 by means of which it is fed through line 79, valve 80 and cooler 81, passing therefrom, after being cooled to any desired degree, through line 82, valve 83 and line 84 into chamber 10, entering this zone either through line 72 or through line 74, as previously described, or at any other desired point in the chamber (not shown). Another suitable oil for the purpose described comprises a portion of the high-boiling fractions of the reflux condensate withdrawn from the lower portion of fractionator 33 including in some cases, as will be later more fully described, secondary charging stock or high-boiling fractions thereof supplied to fractionator 33. This oil may be diverted from line 60 through line 86 and valve 87 and through line 76 to pump 78 to be fed therefrom, either alone or together with, condensate from line 38, to chamber 10, as previously described. When desired, a portion or all of the oil thus recirculated to chamber 10 may by-pass cooler 81 by means of valve 85, in line 84.

Simultaneous with the operation already described, a secondary charging stock comprising any desired oil, ranging, as already ind cated, from distillate to residual oil, is supplied through line 88 and valve 89 to pump 90 by means of which it is fed, in the case illustrated, through line 91, valve 92, heat exchanger 93, line 94 and valve 95 into fractionator 33, entering this zone at any desired point. Heat exchanger 93 offers a means of preheating the secondary charging stock by means of heat recovered from the fractionated vaporous products of the process, prior to their introduction into condenser 52 and prior to the introduction of the secondary charging stock into the fractionator. It will be understood that the secondary charging stock may, when des red, be supplied to the fractionator without preheating or that it may be preheated to any desired degree in any well known manner (not shown). The secondary charging stock thus supplied to fractionator 33 is subjected to vaporization in this zone by direct contact and heat exchange with the vaporous conversion products of the process undergoing fractionation in this zone serving to assist fractionation of the vapors.

When the secondary charging stock contains materials within the boiling range of the desired final light distillate product of the process they

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are vaporized within the fractionator, withdrawn therefrom, subjected to condensation and collected together with the distillate resulting from conversion. Higher boiling fractions of the secondary charging stock corresponding in boiling range to the low-boiling fractions of the reflux condensate, returned, as described, to heating coil 6, are collected therewith and subjected to the same treatment. When the secondary charging stock contains any appreciable fractions of higher boiling point than the side-stream supplied to heating coil 6 they collect, together with the high boiling fractions of the reflux condensate, in the lower portion of fractionating column 33 and are returned therewith to further conversion in heating coil 68.

The primary charging stock and selected low-boiling side stream from the fractionator are preferably subjected to a temperature ranging from 950 to 1050° F., at a superatmospheric pressure of from 300 to 800 pounds, or thereabouts, per square inch, measured at the outlet from the heating coil to which they are supplied. The high-boiling fractions of the intermediate conversion products, together with any corresponding fractions of the secondary charging stock, are preferably subjected to a temperature within the range of 850 to 975° F., at a superatmospheric pressure of from 100 to 500 pounds, or more, per square inch, measured at the outlet from the separate heating coil to which this material is supplied. The pressure employed in the reaction chamber may range, for example, from 100 to 500 pounds, or thereabouts per square inch, and preferably is substantially equalized with the pressure at the outlet from the heating coil employing the lowest pressure, in case different pressures are employed in the two heating coils. A reduced pressure ranging, for example, from 100 pounds, or thereabouts, per square inch, down to substantially atmospheric pressure is preferred in the vaporizing chamber and the pressures employed in the succeeding fractionating, condensing and collecting portions of the system may be substantially equalized with or somewhat reduced relative to the pressure employed in the vaporizing chamber.

As a specific example of one of the many possible operations of the process of the present invention, the primary charging stock, which amounts to about 56% of the total oil subjected to conversion in the process, is a 45° A. P. I. gravity naphtha having a boiling range of approximately 265 to 470° F., with an octane number of approximately 35, a sulphur content of about 0.41% and containing about 77% of material boiling up to 400° F. with an octane number of approximately 43. The secondary charging stock is pressure distillate derived from other cracking operations containing about 75% of 400 end-point motor fuel having an octane number of approximately 73 and a sulfur content of about 0.25%. The 25% or thereabouts of material in the secondary charging stock, boiling above 400° F. comprises about 44% of the total oil subjected to conversion in the system, the motor fuel components of the secondary charging stock being recovered, without conversion, together with the motor fuel product of the process, as an overhead stream from the fractionator. Components of the secondary charging stock and intermediate conversion products of the process having an end-boiling point of approximately 650° F. are withdrawn as a side stream from the fractionator and subjected to conversion, together with the primary charging stock, at a temperature of from 970 to 980° F. measured at the outlet from the heating coil. The higher boiling components of the reflux condensate are subjected in a separate heating coil to a conversion temperature of 930 to 935° F. Pressures in excess of 1,000 pounds per square inch are maintained at the inlet to both heating coils and a pressure of approximately 400 pounds per square inch is maintained in the reaction chamber. The pressure is reduced in the vaporizing chamber to about 85 pounds per square inch and is substantially equalized in the succeeding fractionating, condensing and collecting portions of the system. This operation may yield, per barrel of total charging stock, neglecting the 75% or thereabouts of motor fuel in the secondary charging stock which is not subjected to conversion, about 77% of 400° F. end-point motor fuel having an octane number of about 72 and a sulphur content of approximately 0.23%, the additional products of the process being about 15% of low gravity residual oil having a velocity of about 12 seconds Saybolt Furol at 122° F. and containing about 0.5% B. S. and W. and about 430 cubic feet of gas, per barrel of charging stock.

I claim as my invention:

1. A process for the simultaneous cracking of relatively light and heavy charging oils which comprises maintaining hydrocarbon oil under cracking conditions of temperature and pressure in a reaction zone, removing vapors and unvaporized oil as a mixture from said zone, lowering the pressure on said mixture and separating the same in a separating zone into vapors and residue, passing such separated vapors to a fractionating zone and fractionating the same therein in direct contact with the heavier charging oil thereby commingling the latter with the reflux condensate formed by the fractionation, separating the commingled charging oil and reflux during the fractionation into relatively light and heavy liquid fractions, passing such heavy liquid fraction through a heating zone maintained at cracking temperature and thence discharging the same into the reaction zone, at least a portion of said heavy liquid fraction supplied to said heating zone being passed in indirect heat exchange with the vapors being supplied from said separating zone to the fractionating zone and resultant condensate being introduced to the separating zone, combining said light liquid fraction with the lighter charging oil, passing the resultant mixture through a second heating zone maintained at higher cracking temperature than the first-mentioned heating zone and thence introducing the same to the reaction zone, and finally condensing the vapors uncondensed in the fractionating zone.

2. A process for the simultaneous cracking of relatively light and heavy charging oils which comprises maintaining hydrocarbon oil under cracking conditions of temperature and pressure in a reaction zone, removing vapors and unvaporized oil as a mixture from said zone, lowering the pressure on said mixture and separating the same in a separating zone into vapors and residue, passing such separated vapors to a fractionating zone and fractionating the same therein in direct contact with the heavier charging oil thereby commingling the latter with the reflux condensate formed by the fractionation, separating the commingled charging oil and reflux during the fractionation into relatively light and heavy liquid fractions, passing such heavy liquid fraction through a heating zone maintained at cracking

temperature and thence discharging the same into the reaction zone, at least a portion of said heavy liquid fraction supplied to said heating zone being passed in indirect heat exchange with the vapors being supplied from said separating zone to the fractionating zone and resultant condensate being introduced to the reaction zone, combining said light liquid fraction with the lighter charging oil, passing the resultant mixture through a second heating zone maintained at higher cracking temperature than the first-mentioned heating zone and thence introducing the same to the reaction zone, and finally condensing the vapors uncondensed in the fractionating zone.

3. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a cracking zone, removing vapors and unvaporized oil as a mixture from said zone, lowering the pressure on said mixture and separating the same in a separating zone into vapors and residue, passing such separated vapors to a fractionating zone and fractionating the same therein in direct contact with charging oil for the process, passing admixed charging oil and reflux condensate from the fractionating zone in indirect heat exchange relation with the vapors being supplied from the separating zone to the fractionating zone and then introducing the same to the cracking zone, introducing condensate formed by said heat exchange to the separating zone, and finally condensing the fractionated vapors.

4. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a heating coil and reaction zone, removing vapors and unvaporized oil as a mixture from said zone, lowering the pressure on said mixture and separating the same in a separating zone into vapors and residue, passing such separated vapors to a fractionating zone and fractionating the same therein in direct contact with charging oil for the process, passing admixed charging oil and reflux condensate from the fractionating zone in indirect heat exchange relation with the vapors being supplied from the separating zone to the fractionating zone and then introducing the same to the heating coil, introducing condensate formed by said heat exchange to the separating zone, and finally condensing the fractionated vapors.

5. The process as defined in claim 4 further characterized in that condensate formed by said heat exchange is also introduced to the reaction zone.

6. A conversion process which comprises subjecting hydrocarbon oil to cracking conditions of temperature and pressure in a heating coil and reaction zone, removing vapors and unvaporized oil as a mixture from said zone, lowering the pressure on said mixture and separating the same in a separating zone into vapors and residue, passing such separated vapors to a fractionating zone and fractionating the same therein in direct contact with charging oil for the process, passing admixed charging oil and reflux condensate from the fractionating zone in indirect heat exchange relation with the vapors being supplied from the separating zone to the fractionating zone and then introducing the same to the heating coil, introducing condensate formed by said heat exchange to the reaction zone, and finally condensing the fractionated vapors.

LYMAN C. HUFF.

COMPLETE SPECIFICATION.

Improvements in the Method and Means of Refining Crude and Refuse Petroleum and the like.

I, PERCY HADDAN, of the firm of Herbert & Co., Patent Agents, of 18, Buckingham Street, Charing Cross, London, in the County of Middlesex, Civil Engineer, do hereby declare the nature of this invention, a communication to me from abroad by Geo. L. Benton of Titusville, Pennsylvania, United States of America, Manufacturer, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

This invention consists in a method and means for producing lighter hydrocarbons from the refuse of petroleum oil, tar-oils and other heavy mineral oils and of refining crude petroleum.

In the accompanying drawing, Fig. 1 is a vertical sectional elevation of the apparatus.

Fig. 2 is a horizontal section on the line a a of Fig. 1, and

Fig. 3 a top view of the same.

The apparatus serving for this purpose consists of a series of pipes B arranged in a furnace A, by which the series is heated. The range of pipes communicates on the one side with a force-pump T and on the other side with a vapour chamber C, before the latter a stop-valve *g* is applied for regulating the supply, so that it is possible (by a suitable adjustment of the same) to maintain a considerable pressure (285 pounds or more to the square inch) in the pipes.

The refuse of petroleum oil, tar oils and the like are forced under a considerable pressure by the force pump T through the pipes, in which they are heated. On the entrance of the liquid into the vapour-chamber C which may be under pressure of one atmosphere, or which may be exhausted to any lower pressure as desired, a rapid evaporation of the heated hydrocarbons is effected.

The vapour-chamber C is heated to avoid the condensation of the vapours generated therein, which pass therefrom to a condensing apparatus H, in which they are condensed. The heavier liquids not evaporated flow off at the bottom of the vapour-chamber at A.

In order to avoid additional pressure in the pipe B, a suitably weighted check valve *g* is placed between the force pump T and the series of pipes B, which valve does not allow the return of the liquid into the tank of the pump if the intended pressure is surpassed.

For producing refined oil from crude petroleum the process is performed in the same manner in the apparatus but under a lower pressure.

Having now particularly described and ascertained the nature of this invention and in what manner the same is to be performed, I declare that what I claim is:

1) The method and means for producing lighter hydrocarbons from the refuse of petroleum-oil, tar oils and other heavy mineral oils, consisting in heating said oil or

oils under high pressure to a temperature above boiling point thereof during the supply through a series of pipes.

2) The refining of crude petroleum by means of the same method under a lower pressure.

3) The method of evaporating under low pressure in a heated vapour chamber aforesaid oils superheated under high pressure.

4) The continual flowing off of the heavier (not evaporated) liquids at the bottom of the vapour-chamber.

5) The combination of said vapour chamber with a heated range of pipes, being under pressure and with a condensing apparatus as set forth.

6) The combination with the above apparatus of a check valve at the entrance of the series of pipes B and of an adjustable valve between the range of pipes and the vapour chamber.

Dated this 25th day of October 1887.

PERCY HADDAN.

By Herbert & Co.,
18, Buckingham Street, Strand, W.C.,
Agents to Applicant.

LONDON: Printed for Her Majesty's Stationery Office
By DARLING AND SON.

1887.

A.D. 1887. Feb. 7. № 1922.

HADDAN'S COMPLETE SPECIFICATION.

(1 SHEET)

Fig 1

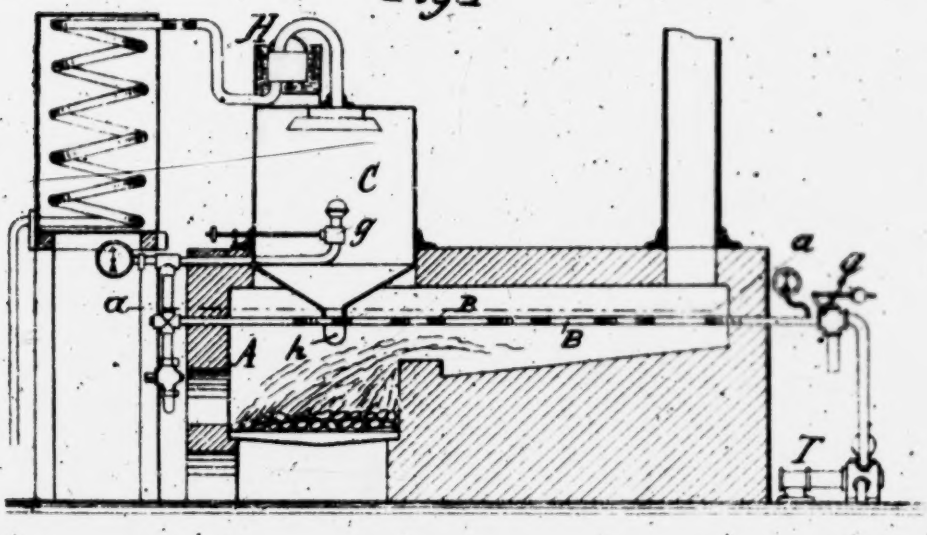


Fig 2

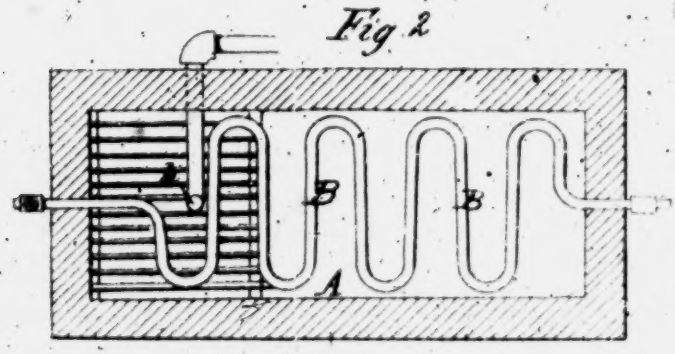
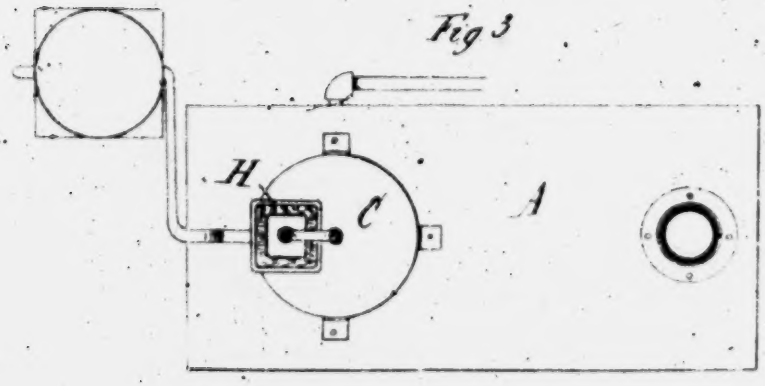


Fig 3



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London: Printed by Darling and Son
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3531

N° 1308 A.D. 1891

Date of Application, 24th Jan., 1891—Accepted, 14th Mar., 1891

COMPLETE SPECIFICATION.

Improvements in the Continuous Distillation of Hydrocarbon and other Oils and Liquids.

I, CAEL MARIA PIELSTICKER, of 43, Connaught Road, Harlesden, N.W., in the County of Middlesex, Engineer, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

My invention relates to improvements in the distillation of hydrocarbon and other oils and liquids by means of which the operation of distillation is conducted in a continuous manner.

In the Specification to Letters Patent granted to me in Great Britain under No. 1706 and dated April 10th 1882 I described a method in which the hydrocarbon oil was forced under pressure by means of a force pump, or a steam injector into a coil open at the other end, in which coil the oil was heated to its distilling point, the heated oil entering from the coil into a heated retort in which it was vaporised and again condensed in a cooler connected with the retort.

In employing this apparatus it was found difficult to so regulate the temperature of the coil, that all the oil at once assumed vapour form on entering the retort, while at other times the coil became so superheated that a portion of the oil became converted into permanent gas.

Moreover the coil being directly exposed to the action of a high temperature was burned through in a short time and finally it was found impossible to clean the coil from the carbon deposited therein from the oil passing through it. These defects have been obviated by improvements set forth in my Specification No. 6466 of 1890 and the object of the improved apparatus which I will now proceed to describe by reference to the accompanying drawing is to obtain a yet more perfect and continuous operation.

On the accompanying drawings :—

Figure 1 is an elevation showing general arrangement of oil tank, pump, and heating coil.

Figure 2 an elevation showing the arrangement of retort and condenser.

Figure 3 is an enlarged section through the dome and goose neck.

Figure 4 is a longitudinal section through the retort showing arrangement of baffle plates.

Figure 5 is a transverse section through the same.

Figure 6 illustrates the methods of connecting the pipes by means of short bends.

Figure 7 is a detail of a tar outlet from retort fitted with steam ejector.

Figure 8 a sectional elevation of a column still, and

Figure 9 is an elevation showing the arrangement of a retort and second heating coil.

A the oil tank.
B steam coil.
C pump or injector.
D heating coil.
E block of iron.
F iron cover.
G inlet to retort, G^1 outlet valve to second retort D^1.
H steam connection to heating coil, H^1 steam injector to second coil D^1.
I retort, K baffle plates.
L passage at bottom of plate.
M movable cover of retort.
N tar outlet valve on retort I.

[*Price* 8*d*.]

O steam inlet to valve N.
P the dome, P^1 oil pipe.
Q goose neck, Q^1 second bend, R contraction or valve in goose neck.
S baffle plates in dome.
T cup inside dome.
U small vessel or condenser.
U^1 second vessel or condenser.
V draw off cocks.
W column still.
X baffle plates in column still.
Y draw off cock for tar.
Z steam ejector.

The oil to be distilled is contained in a tank A, in which it is heated by means of a steam coil B, or otherwise. From this tank the oil is forced by means of a pump C, or otherwise, into a coil D which is formed of a number of iron pipes, embedded or inserted into a solid block of iron or refractory material E closed by covers F as described and claimed in my Specification No. 6466 of 1890.

Between the force pump C and the inlet of the coil D, a steam connection H is provided for the purpose of emptying the oil contained in the coil D at the end of the operation by a steam blast into a retort I into which the other end of the coil D feads; otherwise when the pumping is stopped the oil remaining in the coil D would speedily become carbonised and choke the coil.

Between the pump C and the coil D and between the coil D and retort I expansion joints may be provided. The retort I is provided with a number of baffle plates K causing the oil vapours to take a lengthened passage through the retort, before they can enter the condenser U.

A passage L is left in the lower part of the baffle plates in order to obtain the flow of the tar or residuum to the draw off cock.

The end of the retort opposite to the inlet of the oil is closed by a removable cover M.

Nearly at the lower end of the cover is fitted a valve N, for the removal of the tar or residue during the operation of distilling, a steam inlet O being connected with the tar outlet, in order to blow steam when the tar outlet is opened, which not only assists in the removal of the thick tar or the residue but more particularly prevents air from entering the retort, which air would form a dangerously explosive mixture with the highly heated oil gases inside the retort.

It will be evident that since a constant supply of oil is thus fed into the retort I and the residuum of this oil or other liquid entering the latter, by preference from the highest point of the coil, being constantly removed during the distillation, this distillation thus becomes continuous.

A dome P and goose neck Q connects the retort with a condenser. The dome P may be enlarged at its base forming a sphere, and may be provided at its lower end inside with a cup shaped projection T, into which any oil collects which may condense in the dome P and from which it may be returned into the retort I or into the supply tank A, through the pipe P^1. This dome may be provided with a number of baffle plates S, which force the vapours to come in contact with the inner surface of the dome P, where the heavier portion of them are caused to condense and returning to the more heated surface of the retort, are reduced in gravity and finally distill over and condense in the condenser.

The condenser may either be an ordinary coil or a surface condenser, the first bend of which reaches into a vessel U nearly to the bottom of the latter, in which part of the vapours condense; the uncondensed portion being led by the second bend Q^1 from the top of the first vessel U to the bottom of the second vessel U^1 and so on through a series of condensing vessels, which are all provided with draw off cocks V in which the vapours are successively condensed into oil of a number of graduated specific gravities, heavier at the beginning of the series and lighter towards the end of the series.

Or instead of this arrangement, the products of distillation as they pass over from the retort I may be fractionally separated into a number of oils of graduated specific gravities by connecting the heating coil with a column still W, which may be similar to that used in the distillation of benzol, the body of which column still I also divide by baffle plates X and a draw off cock Y for the tar or residue with steam ejector Z.

When it is intended to produce still lighter gravity oils, a valve R may be placed between the outlet of the retort I and the condenser U which may be kept open only so far as to create a certain pressure of the gases inside the retort, or such pressure may be created by means of a steam blast, introduced into the goose neck Q, and blowing in the opposite direction to the flow of vapours which distill over from the retort, or the goose neck Q may be contracted at some point to a much smaller diameter by valve R or otherwise.

In case the crude oil contains a considerable quantity of water, the latter may be separated from the oil by placing the baffle plates horizontally into the retort, over which the oil and water flows, presenting in this manner a very extended surface, which is most conducive to rapid evaporation. The coil D and the retort I are kept at the temperature at which only the water distills off, while the oil pumped through the coil and retort is drawn off at the tar cock Y free from water and in a subsequent operation may be subjected to distillation.

If the manufacture of permanent gas or of very light oil is intended, the retort I is directly connected with a second coil D^1 similar to the first one D; steam, which may previously have been superheated, being in preference simultaneously admitted with the oil vapours into the second coil D^1 by means of a steam injector H provided for the purpose; the second coil may be kept under pressure by means of a valve G^1 or otherwise, and may be connected with expansion chamber or gasholder and condenser of well known construction.

My apparatus may also be used for the distillation of other liquids besides hydrocarbons, for instance for fats and oils in the separation of fatty acids and glycerine.

Also for the continuous production of distilled water from sea water or the concentration of brine and alkaline solutions, the concentration of sugar solutions, the salt water, alkaline, or other solution being in this pumped through the heating coil, the greater portion of the water distills over in the retort provided with horizontal baffle plates and which in this case may be provided with an exhauster or vacuum pump. The concentrated salt alkaline or other solution may be drawn off at the draw off cock at the end of the retort.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is:—

1. An apparatus for the continuous distillation of hydrocarbon and other oils and liquids consisting of a supply tank, means of heating the same, of forcing the liquid into and through a heated coil connected with a steam jet or blast, from thence into and through a retort provided with baffle plates and draw off cock fitted with steam ejector, to a condenser; the whole constructed, combined and arranged to operate substantially as hereinbefore described and illustrated on the drawing.

2. An apparatus for continuous distillation of hydrocarbon and other oils and liquids consisting of a supply tank, means of heating the same, of forcing the liquid into and through a heated coil, connected with a steam jet or blast, from whence it passes into and through a retort provided with baffle plates and draw off cock fitted with steam ejector, thence into and through a second heating coil which may or may not be provided with a steam inlet and the outlet of which may or may not be provided with means of retarding the outflow and which may lead into an expansion chamber and thence to a condenser in communication with a gasholder or other receptacle, the whole substantially as hereinbefore described.

3. In apparatus for the continuous distillation of hydrocarbon and other oils

liquids constructed as hereinbefore described and claimed, increasing the velocity of the flow of the liquid through the heating coil from the inlet towards the outlet by a contraction of the outlet as compared with the inlet substantially as and for the purpose specified.

4. In apparatus for the continuous distillation of hydrocarbon oils and other liquids, the application of a steam ejector to the draw off cock for the residue substantially as hereinbefore described.

5. In apparatus for the continuous distillation of hydrocarbon and other oils and liquids, means of forcing the oil out of the coil at the end of an operation whereby the carbonisation of the oil contained in the coil is prevented substantially as hereinbefore described.

6. In apparatus for the continuous distillation of hydrocarbon and other oils and liquids, a dome, connecting a retort with the goose neck and condenser, provided inside at its base with an annular cup, in which the heavier portions of the oil vapours condensed in the dome collect, and from where they can be returned into the supply tank, or into the heating coil, or into the retort, substantially as described.

7. In apparatus for the continuous distillation of hydrocarbon and other oils and liquids constructed as hereinbefore described and claimed, means of separating the distillate fractionally, substantially as described.

Dated this Twenty-fourth day of January 1891.

For the Applicant,
W. E. GEDGE,
Agent.

London: Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1891.

A.D. 1891: JAN. 24. N° 1308.

PIELSTICKER'S COMPLETE SPECIFICATION.

Fig 2

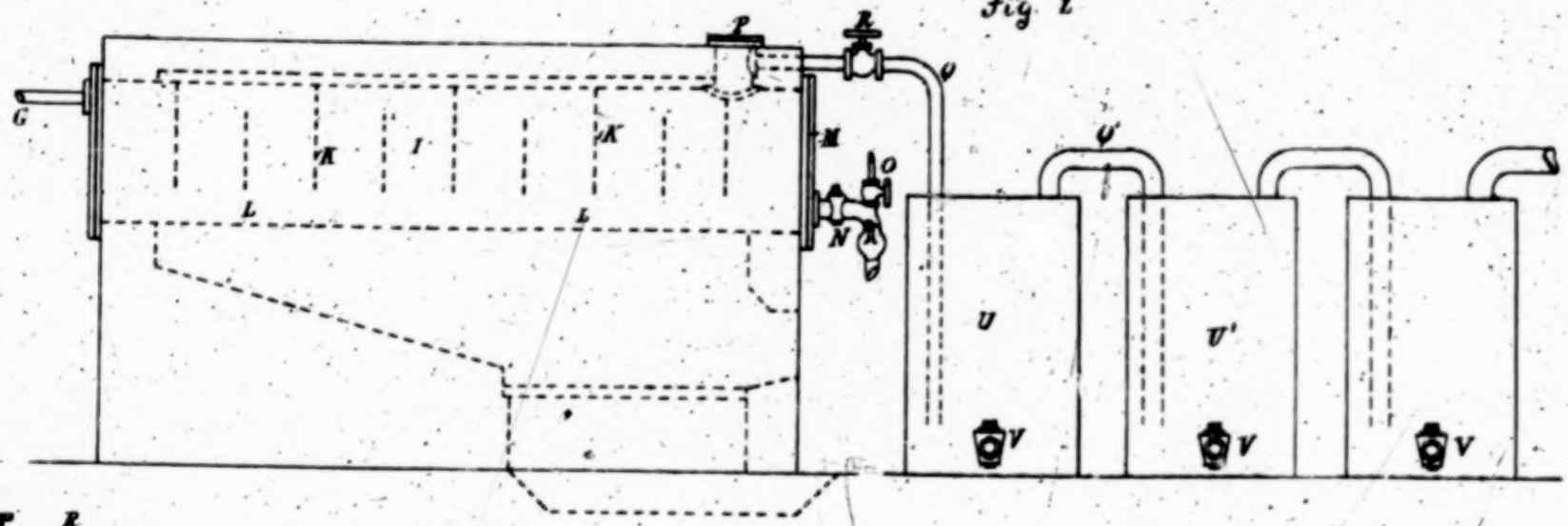


Fig. 3

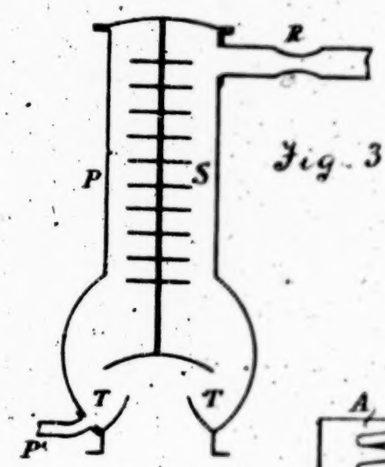
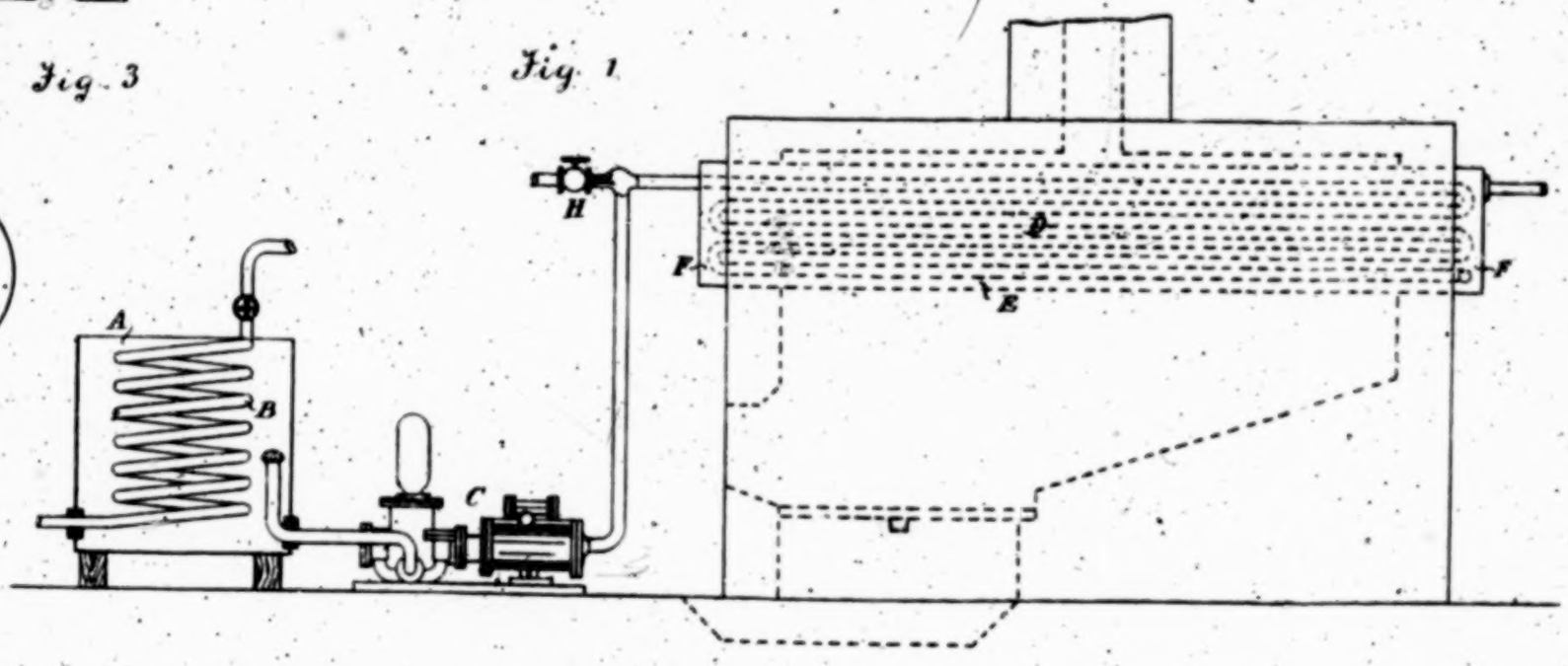


Fig. 1



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A.D. 1891. Jan. 24. N° 1308.

PIELSTICKER'S Complete Specification.

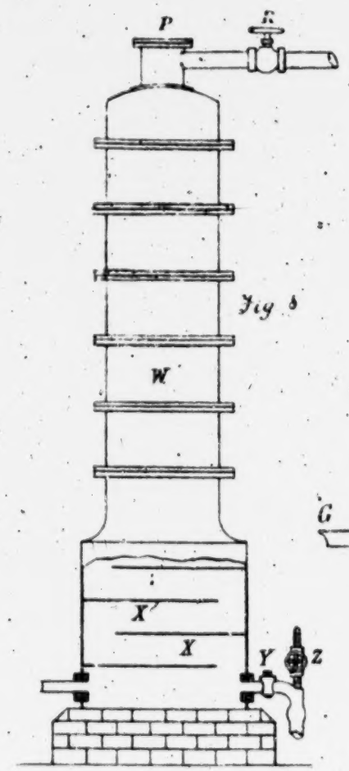


Fig 5

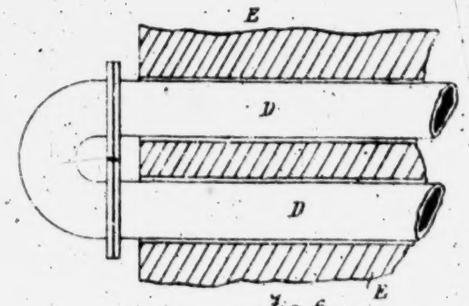


Fig 6.

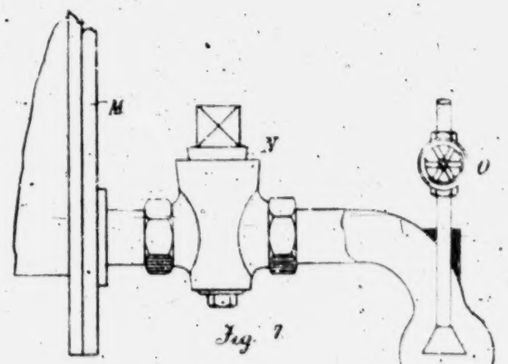


Fig 7

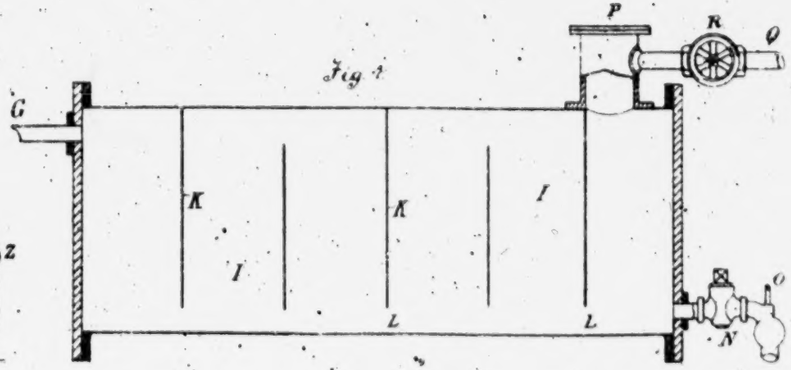


Fig 4

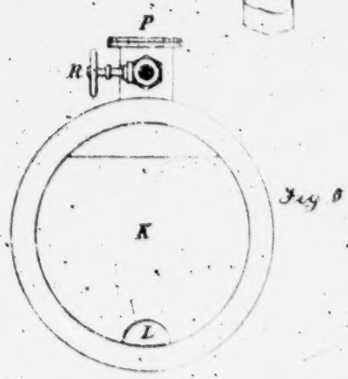


Fig 8

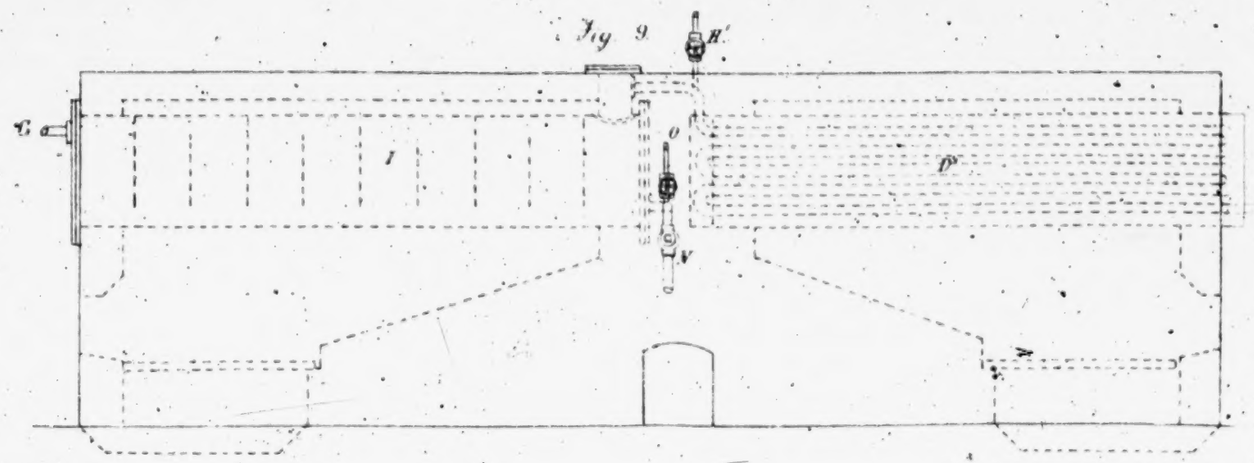


Fig 9

[This Drawing is a reproduction of the Original on a reduced scale.

London: Printed by Darling and Son, Ltd.
for Her Majesty's Stationery Office. 1891.

SPECIFICATION in pursuance of the conditions of the Letters Patent filed by the said Carl Maria Pielsticker in the Great Seal Patent Office on the 6th October, 1882.

CARL MARIA PIELSTICKER, of 5, Sydney Terrace, Kilburn, London, in the County of Middlesex. "AN IMPROVED METHOD FOR THE CONTINUOUS DISTILLATION, BOILING, SAPONIFICATION AND ACIDIFICATION OF FATS, OILS, GLYCERINE, ROSINS AND HYDRO-CARBONS, AND IMPROVED APPARATUS IN CONNECTION THEREWITH."

My invention relates to an improved method for the continuous distillation, boiling, saponification, and acidification of Fats, Oils, Glycerine, Rosins and hydro-carbons; and approved apparatus in connection therewith.

In carrying out my invention, I employ an apparatus hereinafter called the "Injector" consisting of an iron or copper pipe A say about 24 inches long and 2 inches diameter contracted near its outlet to one half its diameter and widening again at the mouth; another pipe B, about $^3/_4$ of an inch in diameter is connected with a steam super heater, contracted near its outlet and widening again at the mouth and entering into the first mentioned pipe at the back to the extent of say 12 inches; a third pipe C, about $1^1/_4$ inch diameter and connected with a tank T, containing liquid fat or oil or hydrocarbons enters the pipe A at right angles at a point about one half its length. The tank T, must be placed sufficiently high, so as to permit the oil *etcetera* to enter the injector with some pressure or a force pump may be inserted between the tank T and the injector. Another similar pipe D parallel to the pipe C, may lead to a tank containing either an alkaline solution or acid.—The pipes B and C and D are supplied with stop cocks in order to regulate the flow of steam or fat *etcetera*. I may use other forms of "Injector" by which a spray of fat *etcetera* by means of a steam jet is produced for the purposes of my process and I do not confine myself to the above described form of "Injector" only. A metal coil E by preference of copper say about $1^1/_2$ inch diameter and not less than from 50 to 60 feet long is connected with the "Injector" and enters a horizontal retort G of copper or iron of say about 24 inches wide by 20 inches in height and from 12 to 15 feet long and divided by partitions in such a way that steam and vapours introduced at the outlet of the coil are obliged to circulate forward and backwards inside the retort. The inside of the retort is by preference filled with coarse pieces of coke or brick, in order to present a larger heating surface and to retard the passage of oil *etcetera* and the steam. At the back of the retort is a door H for cleaning and the retort has an outlet over the top and connected with a condenser. The whole of the coil and retort is enclosed in a furnace having the fire placed at the back of and under the retort G.

In working my process I first heat the "Injector" the coil and the retort by admitting superheated steam to the "Injector" and also by starting a fire under the retort and coil. As soon as a temperature has been obtained at which the fats *etcetera* distill over, which differs according to the nature and composition of the fat, oil, glycerine, rosin or hydrocarbon. I admit the liquid fat *etcetera* into the "Injector" in preference in a heated state. The fat *etcetera* is impinged upon inside the "Injector" by the steam and an intimate mixture of steam and fat *etcetera* in a state of minute division is blown through the coil into the retort. The fat *etcetera* attaining a distilling temperature inside the coil is at once vaporised inside the retort and condensed on its passage through the condensor.

The products of distillation whether from animal, vegetable, or mineral oils, or fats, rosin paraffin, or Ozokerit, are further treated in the ordinary way.

When the production of illuminating gas from hydro carbon oils is intended, the temperature of the coil or retort is raised sufficiently high to produce permanent

gases and to cause the decomposition of the steam by the latter coming in contact with the incandescent coke inside the retort. In addition to the condenser the usual gas purifier will in this case be attached.

As some of the special advantages of this process I will mention:—The operation being continuous and without interruption practically as long as may be desired a minimum of plant is required. The fats *etcetera* being atomised by the steam present an immensely extended surface: distillation therefore taking place with the greatest possible rapidity and at a lower temperature. Only small quantities of fat *etcetera* being at any time under the influence of heat and then only for the very shortest possible time the products of distillation are of a better color, no acralein is formed and the yield is larger.

The fats *etcetera* before admission into the "Injector" may previously have been treated with acid.

Glycerine is distilled in the same manner by means of the "Injector" coil, and retort.

The coil and retort may be heated by means of a steam jacket around the coil and retort.

In case the retort, or the passages in the retort, are long enough to heat the fat *etcetera* up to distilling point in their passage through them, the coil may be done away with and the mouth of the "Injector" enter direct into the retort.

Instead of a horizontal retort, a vertical retort, boiler or still with a series of Baffle plates inside may be used.

Linseed oil and other oils are boiled in a continuous way by means of the "Injector" coil and an open boiler, keeping the temperature below the distilling point and allowing air to be sucked up by the steam in the "Injector" by having a number of small holes in the "Injector" just behind the inlet of the supply pipe of the materials to be treated.

When the fats or oils to be operated upon for the production of fatty acids and glycerine are of animal or vegetable origin and are to be treated by the saponification process, I bring them previous to their admission in the "Injector" in a state of emulsion with about 25 to 30 per cent. of weak lime water or other weak caustic alkaline solution, or I allow the alkaline solution to enter the "Injector" in every instance in a heated state by a separate pipe and find that a quantity of from four to six per cent. of alkali in proportion to the fat or oil is already sufficient, the temperature of the steam coil and retort, boiler or other receptacle, being maintained at about 200 centigrade.

In this case actual distillation does not take place, but the saponified fatty acids and glycerine will collect inside the retort, from which they may be drawn off at the bottom by means of a cock.

Instead of a retort a boiler or any other similar receptacle furnished with an outlet or condenser will answer the purpose. When the boiler is sufficiently filled the supply of fat or alkali is shut off from the Injector and the steam from the Injector continued until a sample shews that no more neutral fats are present.

Instead of an alakline emulsion a mixture of fat or oil with concentrated sulphuric acid of from 3 to 6 of acid, may be passed through the "Injector" and coil into the retort or similar receptacle at a temperature of about 150 Centigrade or weaker acid at a higher temperature and all the apparatus is made of or lined with a non corroding material such as lead or earthenware. The acidified fat or oil is then boiled for some time with water. The alkali in the former case or the acid in the latter case is then neutralized and the fatty acids and glycerine further heated in the usual manner.

When the manufacture of soap is intended by my continuous process, I bring the fats or oils, before their admission into the "Injector," already into a state of emulsion with the correct proportion of alkaline solution to form a neutral soap, the alkaline solution being preferably of a strength of from 30 to 36 "Beaume," or I allow the alkaline solution to enter the "Injector" separately.

The temperature of the steam and of the coil need not exceed 180 Centigrade. The

outlet of the coil enters in this case into a closed boiler or receptacle, near to the bottom, surrounded by a steam jacket and having an outlet at the top. The alkaline mixture of fat or oil is constantly injected into the boiler kept in a state of agitation and the soap boiled up in a very short time. When the boiler is sufficiently filled the admission of alkali and fat or oil into the "Injector" as well as the steam is then stopped; if required, a quantity of hot water may be added to the contents of the boiler and steam is then admitted to the jacket and continued until the soap is finished.

Having now described and ascertained the nature of my said invention and in what manner the same is or may be performed.

I claim as secured to me by the hereinbefore in part recited Letters Patent.

Firstly:—The continuous distillation of fats, oils, glycerine, rosins, and hydrocarbons by forcing an intimate mixture of fats, oils, glycerine, rosin, or hydrocarbons and steam through a coil, pipes or retort connected with a condenser and kept at the distilling point of the fat, oil, glycerine, rosin, or hydrocarbon under treatment, substantially as hereinbefore described.

Secondly:—The continuous production of illuminating and heating gas by forcing an intimate mixture of steam and hydrocarbons through a coil and retort, the latter filled with coke, in a state of incandescence, as specified.

Thirdly:—The continuous boiling of linseed oil, and other oils, by forcing an intimate mixture of linseed oil, or other oils, with steam and air through a coil into a boiler kept at a temperature a little below the distilling point of the oil, substantially as hereinbefore described.

Fourthly:—The continuous saponification and acidification of fats and oils for the production of fatty acids and glycerine, by forcing an intimate mixture of fat or oil and alkaline solution, or sulphuric acid instead of the alkaline solution, through a coil, pipe, or retort kept at an elevated temperature, substantially as hereinbefore described.

Fifthly:—The continuous saponification of fats and oils for the production of soap, by forcing an intimate mixture of steam fat or oil and alkaline solution, in such proportion as to form a neutral soap, through a heated coil or pipe into a closed boiler, substantially as hereinbefore described.

Lastly:—The combination of apparatus substantially as hereinbefore described and shewn on the accompanying Sheet of Drawing, for the purposes set forth.

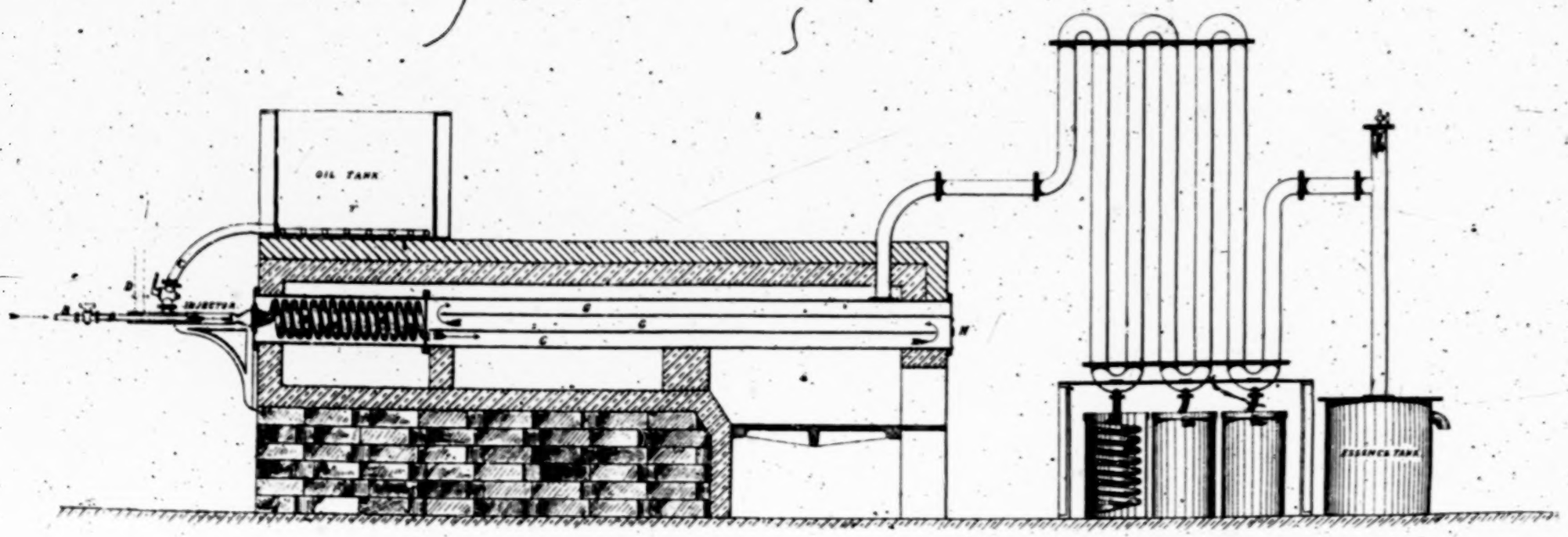
In witness whereof I the said Carl Maria Pielsticker have hereunto set my hand and seal this Fifth day of October, in the year of our Lord One thousand eight hundred and eighty two.

C. M. PIELSTICKER. (L.S.)

Abingdon: Printed for His Majesty's Stationery Office, by Burgess & Son.
[Wt. 33A.—50/10/1930.]

A.D. 1882. APRIL 10. N° 1706.
PIELSTICKER'S SPECIFICATION.
8th Edition

1 SHEET



This Drawing is a reproduction of the Original on a reduced scale.

Charles & Read Ltd Photo-Litho

APR 14 1891
3545

N° 6466 A.D. 1890

Date of Application, 28th Apr., 1890
Complete Specification Left, 24th Jan., 1891—Accepted, 7th Mar., 1891

PROVISIONAL SPECIFICATION.

Improvements in the Distillation of Hydrocarbon and other Oils.

I, CARL MARIA PIELSTICKER, of Suffolk House, Cannon Street, in the City of London, and County of Middlesex, Engineer, do hereby declare the nature of this invention to be as follows :—

My invention relates to improvements in the distillation of hydrocarbon (and other oils) by means of which not only the operation of distillation is conducted in a continuous manner but also a lighter oil of one uniform gravity is obtained as the product of such distillation than the heavier gravity of the raw material subjected to distillation.

According to Letters Patent granted to me in Great Britain under number 1706 and dated April 10th 1882 the hydrocarbon oil was forced under pressure by means of a force pump, or otherwise, into a coil open at the other end, in which the oil was heated to its distilling point, the heated oil entering from the coil into a heated retort in which it vaporised and again condensed in a cooler connected with the retort.

In employing this apparatus it was found that it was difficult to so regulate the temperature of the coil that all the oil at once assumed vapour form on entering the retort, while at other times the coil became so superheated that a portion of the oil became converted into permanent gas.

In this my improved apparatus this difficulty is avoided by maintaining the coil at a uniform temperature and by keeping the heated oil inside the coil under a certain regulated pressure before it can enter the retort in which it becomes volatilized.

My improved apparatus is constructed in the following manner—

The oil to be distilled is contained in a tank, in which it is heated by means of a steam coil. From this tank the oil is forced by means of a pump, or by means of a steam injector, or otherwise, into a coil made of iron and placed in a heating furnace. The coil is contained in an iron cylinder, which latter is filled with a metal or a salt of known melting point, so that the coil and the oil passing through the latter can assume the same temperature as the bath of molten metal or salt surrounding the coil. In preference I make use of a coil which consists of a number of iron pipes, say ten feet long and one inch (more or less) in diameter, the ends of which are open, and the whole of the pipes cast into a solid block of iron. The ends of the pipes are closed by means of an iron cover, which is provided with channels, so that the pipes form one continuous coil which cover can be easily removed and the pipes be occasionally cleared of the carbon deposited inside from the heated oil, by simply forcing an iron rod through the length of each pipe forming the coil.

This construction of the heating coil is a matter of great importance, since it is impossible to clear an ordinary coil of the requisite length from any solid matter adhering inside.

Between the force pump and the heating coil I place a pressure gauge to indicate the pressure prevailing in the coil, and a valve to prevent any pressure resulting from the heated oil inside the coil to act directly on the force pump.

An expansion joint is provided between this valve and the coil to allow for any expansion of the latter when heated. The other end of the coil leads directly into a retort placed in a furnace which retort is provided with a cooler, or condensor. Between the lower end of the coil and the retort I place a pyrometer, to indicate the temperature of the heated oil and further a valve which is weighted to lift automatically and which then connects the coil with the retort, when the requisite

pressure resulting from the high temperature of the oil equal to its distilling point inside the coil is reached.

When this valve is thus lifted the contents of the coil are ejected automatically in the liquid state into the heated retort, in such a ratio as to distil over just as fast as they are injected. A steam jet inside the retort may assist in drawing the vapours more quickly into the condensor.

When it is intended to produce still lighter gravity oils or even permanent gas, for the production of which the temperature of the coil and retort has to be kept higher and the distillation inside the retort conducted more slowly or retarded by means of baffle plates fitted inside the retort, a second self lifting valve might be placed between the outlet of the retort and the condensor.

Dated this 28th day of April 1890.

C. M. PIELSTICKER.

COMPLETE SPECIFICATION.

Improvements in the Distillation of Hydrocarbon and other Oils.

I, CARL MARIA PIELSTICKER, of Suffolk House, Cannon Street, in the City of London, Engineer, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement :—

My invention relates to improvements in the distillation of hydrocarbon (and other oils) by means of which not only the operation of distillation is conducted in a continuous manner but also a lighter oil of one uniform gravity is obtained as the product of such distillation than the heavier gravity of the raw material subjected to distillation.

According to Letters Patent granted to me in Great Britain under No. 1706 and dated April 10th 1882 the hydrocarbon oil was forced under pressure by means of a force pump, or otherwise, into a coil open at the other end, in which the oil was heated to its distilling point, the heated oil entering from the coil into a heated retort in which it vaporised and again condensed in a cooler connected with the retort.

In employing this apparatus it was found that it was difficult to so regulate the temperature of the coil that all the oil at once assumed vapour form on entering the retort, while at other times the coil became so superheated that a portion of the oil became converted into permanent gas.

The oil to be distilled was contained in a tank, in which it was heated by means of a steam coil. From this tank the oil was forced by means of a pump, or by means of a steam injector, or otherwise, into a coil made of iron and placed in a heating furnace. The coil was contained in an iron cylinder, which latter was filled with a metal or a salt of known melting point, so that the coil and the oil passing through the latter could assume the same temperature as the bath of molten metal or salt surrounding the coil.

On the accompanying drawings :—

Figure 1 being an elevation showing general arrangement of oil tank pump, and heating coil.

Figure 2 an elevation showing the arrangement of a retort and condenser.

It will be seen that I now make use of a coil A which is formed of a number of iron pipes, say ten feet long and say an inch and a half more or less, in diameter, the ends of which are open and the whole of the pipes embedded or inserted into a solid block of iron or refractory material B provided with longitudinal channels, through their entire length into which the pipes fit.

The ends of the pipes are closed by means of an iron cover C which is provided with channels E so that the pipes A form one continuous coil. In this case the cover C can be easily removed and the pipes be occasionally cleared of the carbon deposited inside from the heated oil, by simply forcing an iron rod through the length of each pipe forming the coil.

This construction of the heating coil is a matter of great importance, since it is impossible to clear an ordinary coil of the requisite length from any carbon adhering inside. Moreover the coil being loosely inserted into the block of iron or of refractory material B the whole length of the coil is permitted free expansion and the joints are in consequence kept tight.

I have found that by passing the oil through the coil with great velocity I in a great measure prevent the deposition of carbon or heavy matter which would soon choke up the coil. I now find it preferable to attain this object by graduating the diameter of the pipes A forming the coil, for instance if the entire length of the coil is two hundred feet, I construct the first fifty feet of two inch pipes, the second fifty feet of one and a half inch pipes and the last hundred feet of one inch pipes. I may however decrease the diameter of the coil only towards or at the inlet D into the retort.

I may provide an expansion joint between the pump and the coil to allow for any expansion of the latter when heated. The other end of the coil leads directly into a retort placed in a furnace which retort is provided with a cooler or condenser. A steam jet inside the retort may assist in drawing the vapours more quickly into the condenser.

When it is intended to produce still lighter gravity oils or even permanent gas, for the production of which the temperature of the coil and the retort has to be kept higher and the distillation inside the retort conducted more slowly or retarded by means of baffle plates fitted inside the retort, a valve G may be placed between the outlet F of the retort and the condenser as shown in Figure 3.

Having now particularly described and ascertained the nature of my said invention, and in what manner the same is to be performed, I declare that what I claim is :—

1. In apparatus for the continuous distillation of hydrocarbon and other oils and liquids a heating coil consisting of a series of pipes A encased or embedded in a block or blocks of cast-iron or refractory material B, the ends of the pipes being closed and connected by removable covers C having channels or bends E substantially as hereinbefore described and illustrated Figures 1 and 2 of the drawing.

2. In apparatus for the continuous distillation of hydrocarbon and other oils and liquids constructed as hereinbefore described and claimed, the goose neck F connecting the retort with the condenser provided with the valve G for retarding the flow of gas or vapour from the one to the other substantially as described and illustrated Figure 3 of the drawing.

Dated this Twenty-fourth day of January 1891.

For the Applicant,
W. E. GEDGE,
Agent.

London : Printed for Her Majesty's Stationery Office, by Darling & Son, Ltd.—1891.

A.D. 1890. April 28. N° 6466.

PIELSTICKER'S Complete Specification.

3549

(2 SHEET)

(3rd Edition)

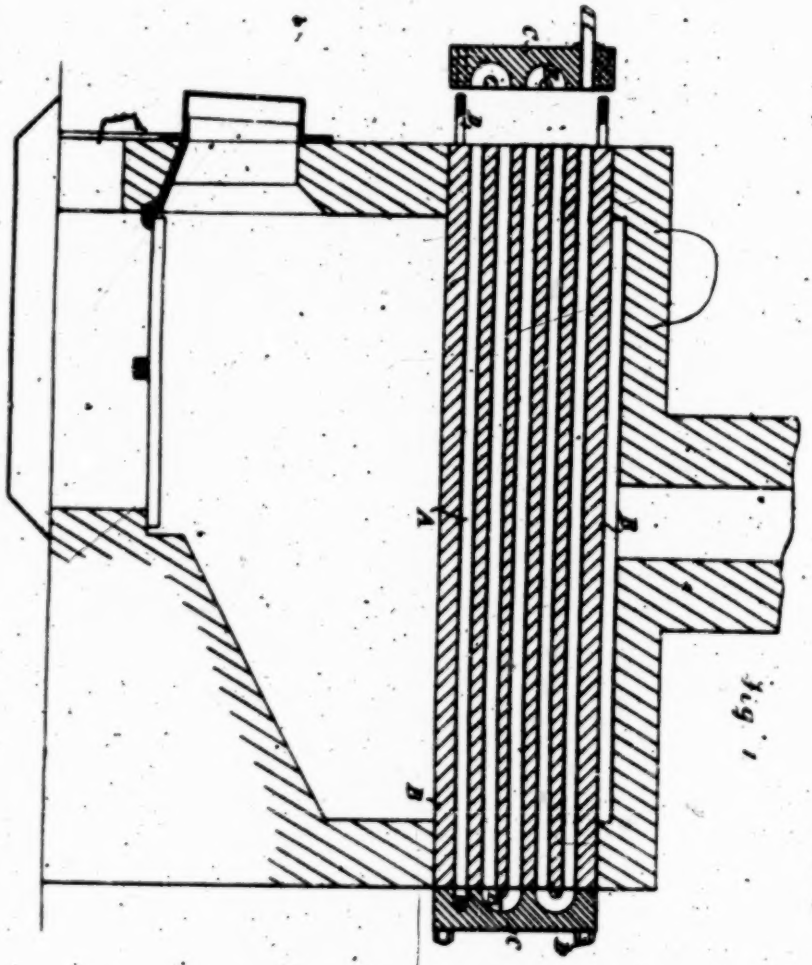


Fig. 1.

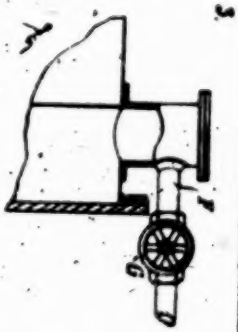


Fig. 3.

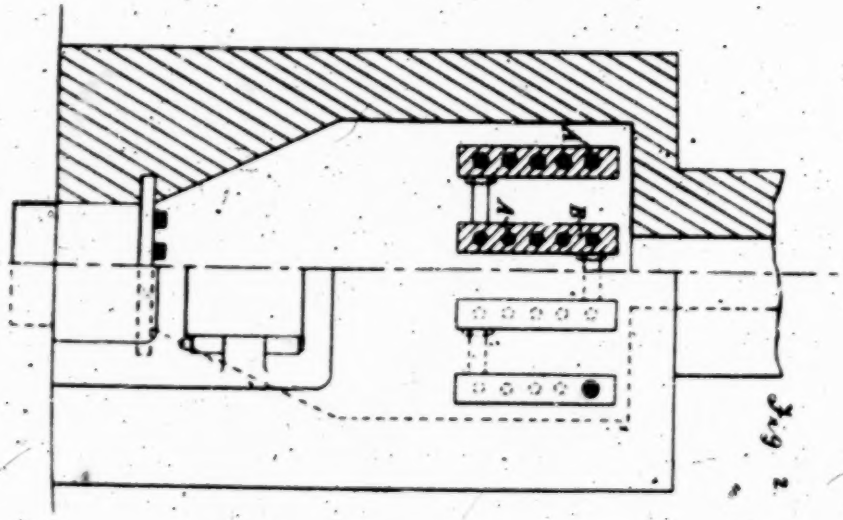


Fig. 2.

[This Drawing is a reproduction of the Original on a reduced scale]

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uncondensed, may be led to a scrubbing and washing plant and hence to a gasometer as hereinbefore stated.

The undistilled oil remaining in the still is drawn off preferably by a syphon pipe, and returned to the supply tank, and fresh heavy oil or liquefied solid hydrocarbon is added from time to time so as to keep the level in the supply tank constant and thus render the whole process a continuous one.

The various tubes or nests of tubes may be provided with inlet and outlet valves and these valves may be such as will resist the effects of the high temperatures and pressures to which they may be subjected. Similarly the various joints may be adapted to accommodate themselves to great changes of temperature and pressure.

Dated this 14th day of March, 1914.

HASELTINE, LAKE & Co.,
28, Southampton Buildings, London, England, and
60, Wall Street, New York City, U.S.A.,
Agents for the Applicants.

COMPLETE SPECIFICATION.

Improvements relating to the Conversion of Heavy Hydrocarbons into Lighter Hydrocarbons.

We, HUGH EMILE FENCHELLE, Merchant, of 378—380, Salisbury House, London Wall, in the City of London, and FREDERICK MOLLWO PERKIN, Ph.D., F.I.C., of 199, Piccadilly, in the County of London, do hereby declare the nature of this invention and in what manner the same is to be performed, to be described and ascertained in and by the following statement :—

This invention relates to the conversion of heavy hydrocarbons into lighter hydrocarbons, the chief object being to provide an improved process of and apparatus for breaking down or "cracking" heavy hydrocarbons efficiently and separating out the resultant lighter hydrocarbons of lower specific gravity, boiling point, and flash point. With this object in view there have been many proposals, such as the heating of a mixture of the heavy hydrocarbon oil and water under pressure, or of steam and oil under pressure, also the passing of hydrocarbon vapours or a mixture of superheated steam and oil over a heated catalytic agent.

It has also been proposed to pass petroleum and similar oil under pressure through heated pipes and then allow it to escape into a heated chamber where much of it vaporises; the passage of heavy hydrocarbon oils through a heated coil and then through a cooled coil in continuation of the heated coil, whilst maintaining a sufficiently high pressure throughout the coils to enable the liquid state throughout the process to be maintained, is also known.

According to the present invention the process involves three main stages, namely heating the oil under pressure, then cooling it while still under pressure, and then allowing it to escape at a lower pressure into a chamber where spontaneous vaporisation of the lighter portions takes place, the conditions for each stage being selected and regulated to ensure the desired result. For this purpose the hydrocarbon oil or liquefied solid hydrocarbon, such as kerosine, naphthalene, or paraffin-wax, is forced under high pressure through one or more long narrow conduits heated to such a degree that the combined effects of temperature and pressure produce a cracking of the hydrocarbon while still in its liquid condition, whereupon this liquid still under pressure is cooled and then passes an obstructing device, for example a check valve, and escapes at atmospheric or other relatively

lower pressure into a chamber surmounted by a dephlegmator or rectifying column, the previous cooling under pressure being such that the subsequent reduction of pressure, on the liquid entering the said chamber, causes a separation of the higher hydrocarbons from the unconverted portion of the liquid by spontaneous vaporisation of the lighter portion; the ascending vapours undergo dephlegmation or rectification, and the residual liquid collects in the chamber. The rectified vapours are conveyed to one or more condensers, and the residual liquid in the aforesaid chamber is led away, and heated in a separate chamber or still by steam generated in a boiler adapted to serve as a heat interchanger between the water to be vaporised and the highly heated oil that has undergone cracking as above stated. In this way the heat abstracted from the cracked oil during the cooling of the latter is usefully employed.

In order that the invention may be clearly understood and readily carried into effect, we will now describe the same more fully with reference to the accompanying drawings, in which :—

Figure 1 is an elevation and Figure 2 a plan of one arrangement of plant suited for treating oil in accordance with the invention.

A is a heating chamber or furnace enclosing a number of nests of tubes the ends of which are supported in the furnace walls and are so connected together as to constitute the long narrow conduit above referred to. The tubes are preferably arranged in two sets A^1 and A^2 as shewn in Figure 1, one set A^1 being of fairly large bore for preheating purposes and the other set A^2 of small bore for the actual cracking operation, the preheating tubes A^1 being arranged in the upper part of the cracking chamber so as to be heated by the hot air and gases rising from the lower part of the chamber where the more intensely heated cracking tubes A^2 are arranged. The heat in the cracking chamber may be obtained in any convenient way, as by the burning of producer gas. A force pump (not shewn) may be employed to drive the heavy hydrocarbon oil or liquefied solid hydrocarbon from a supply tank through the preheating tubes and through the cracking tubes proper at a pressure of from 50 to 60 atmospheres, the tubes being sufficiently strong to safely withstand this pressure. The tubes are preferably straight and open ended, the ends projecting beyond the chamber walls and being connected by detachable bends as above stated, so that individual tubes may be easily inspected and cleaned at any time but constitute a long continuous conduit when in use. Each preheating tube A^1 may be arranged to supply a nest of, say, four cracking tubes, and the whole system of connections, including the necessary valves, is preferably such that a small portion of the tubular arrangement can be thrown out of action without interfering with the action of the remainder.

The hot oil proceeding from the cracking chamber A at a temperature of about 500° to 600° C. gives up some of its heat to the water in a boiler B by passing through a nest or nests of tubes therein, a lift valve being provided on the boiler so that a constant steam pressure can be maintained, thus enabling the temperature to which the oil is cooled in the boiler to be readily maintained and regulated. If for example it is desired to cool the oil to 150° C., the steam pressure in the boiler should be kept at about sixty pounds per square inch. In addition to being heated by the circulation of the hot oil, the water in the boiler B may be also heated by utilising the waste gases from the cracking chamber A; alternatively the hot waste gases may be employed to raise steam in a separate boiler.

The cracked and partially cooled oil proceeds from the boiler B through tubes to a chamber C at the foot of a dephlegmator or rectifying column C^1. The pressure in this chamber C may be about atmospheric, so that the oil, after passing through valves C^2 or other obstructing devices for maintaining the desired pressure in all the tubular passages extending from the force pump to this chamber, is suddenly relieved of pressure, the result being that any occluded gases and all volatile constituents having a natural boiling point below the

temperature of this chamber separate out from the unconverted or "uncracked" oil and pass out of the chamber C into the dephlegmator or rectifying column C^1. In order to watch the flow of the cracked and partially cooled oil into the separating chamber C, a window C^3 or other convenient means of inspection may be provided, and, in order that the sudden ebullition of the oil as it enters the separating chamber may not give rise to entrainment, one or more slanting baffle plates C^4 or the like may be provided near the oil orifices to direct the oil to the bottom of the chamber.

The gases and lighter hydrocarbons spontaneously liberated from the heavier and uncracked oil pass up the dephlegmator or rectifying column C^1 whence they issue at various heights and pass by way of pipes, c, c^1, c^2 into condenser coils D, D^1, D^2 from which the products of condensation, namely hydrocarbon oils of relatively low specific gravity and boiling point, are run by way of pipes, d, d^1, d^2 into receiving or storage tanks (not shewn). The lightest portion of the vapours namely that traversing the pipe c^2, coil D^2, and pipe d^2 may not be entirely condensed, and any uncondensed fraction is passed by way of a branch pipe J into a condenser coil J^1, and thence by way of a pipe J^2 to a storage tank (not shewn).

The heavier or uncracked liquid remaining in the separating chamber C at the foot of the dephlegmator or rectifying column C^1 is run off through a pipe c and passed into a still F, which may be heated in any convenient manner, as by open and closed steam coils. The still F is surmounted by or connected with a second dephlegmator or rectifying column G, and the vapours ascending this column are carried off at different heights or levels by way of pipes, g, g^1, g^2 to separate condenser coils H, H^1, H^2 from which the condensation products are run by way of pipes h, h^1, h^2 into separate receiving or storage tanks (not shewn).

The lightest portion of the vapours, namely that traversing the pipe g^2 and condenser H^2, may not be entirely condensed and any uncondensed fraction leaving the condenser by way of the pipe h^2 is passed by way of a branch pipe K into a condenser coil K^1 and thence by way of a pipe K^2 to a storage tank (not shewn). Any uncondensed gases or vapours may be led to a scrubbing and washing plant and thence to a gasometer, and eventually be used as gaseous fuel for heating the cracking chamber.

In order to heat the still F, steam may be passed through the piping F^x F^2 to a coil F^1 in the still, the steam being conveniently obtained from the boiler B, and the steam or water issuing from the coil F^1 being led to a steam trap.

The liquid collecting at the foot of the dephlegmator G, and the residue in the still F, may be drawn off through a pipe into a cooler I, and thence into a tank M, from which it may be returned to the supply tank of the cracking chamber, fresh heavy oil or liquefied solid hydrocarbon being added to this tank from time to time so as to keep the level therein constant and thus render the whole process a continuous one.

The various tubes or nests of tubes may be provided with inlet and outlet valves and these valves may be such as will resist the effects of the high temperatures and pressures to which they may be subjected. Similarly the various joints may be adapted to accommodate themselves to great changes of temperature and pressure.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. The conversion of heavy hydrocarbons into lighter hydrocarbons, by subjecting the heavy liquid or liquefied hydrocarbon to high pressure and temperature, then cooling the liquid while still under pressure, and allowing it to escape at atmospheric or relatively lower pressure into a chamber where separation of the lighter hydrocarbons from the unconverted portion of the liquid takes place by spontaneous vaporization of the lighter portions.

2. The conversion of heavy hydrocarbons into lighter hydrocarbons by forcing the heavy liquid or liquefied hydrocarbon under high pressure through one or more long narrow conduits heated to such a degree that the combined effects of temperature and pressure produce a cracking of the hydrocarbon while still in the liquid condition, then cooling the liquid while still under pressure and allowing it to escape at atmospheric or relatively lower pressure into a chamber surmounted by a dephlegmator or rectifying column, the cooling under pressure being such that the subsequent reduction of pressure, on the liquid entering the chamber, causes a separation of the lighter hydrocarbons from the unconverted portion of the liquid by spontaneous vaporisation of the lighter portions.

3. In a process of conversion of heavy hydrocarbons into lighter hydrocarbons as set forth in Claim 1; subjecting the liquid residue resulting from the spontaneous vaporisation of the "converted" oil, upon the relief of pressure, to further treatment in a still, substantially as and for the purpose specified.

4. In a process of conversion of heavy hydrocarbons into lighter hydrocarbons as set forth in Claim 3; utilising the heat abstracted from the oil in the course of cooling to raise steam, and utilising the steam thus generated to provide heat in the still, substantially as and for the purpose specified.

5. The herein described process for the conversion of heavy hydrocarbons into lighter hydrocarbons, substantially as described.

6. The plant for converting heavy hydrocarbons into lighter hydrocarbons substantially as hereinbefore described with reference to and as illustrated by the accompanying drawings, for the purposes specified.

Dated this 30th day of July, 1914.

HASELTINE, LAKE & Co.,
28, Southampton Buildings, London, England, and
60, Wall Street, New York City, U.S.A.,
Agents for the Applicants.

Abingdon: Printed for His Majesty's Stationery Office, by Burgess & Son.
(Wt. 33A.—50/5/1930.)

A.D. 1914. MARCH 14. N° 6547.

FENCHELLE & another's COMPLETE SPECIFICATION.

1 SHEET

3rd Edition

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

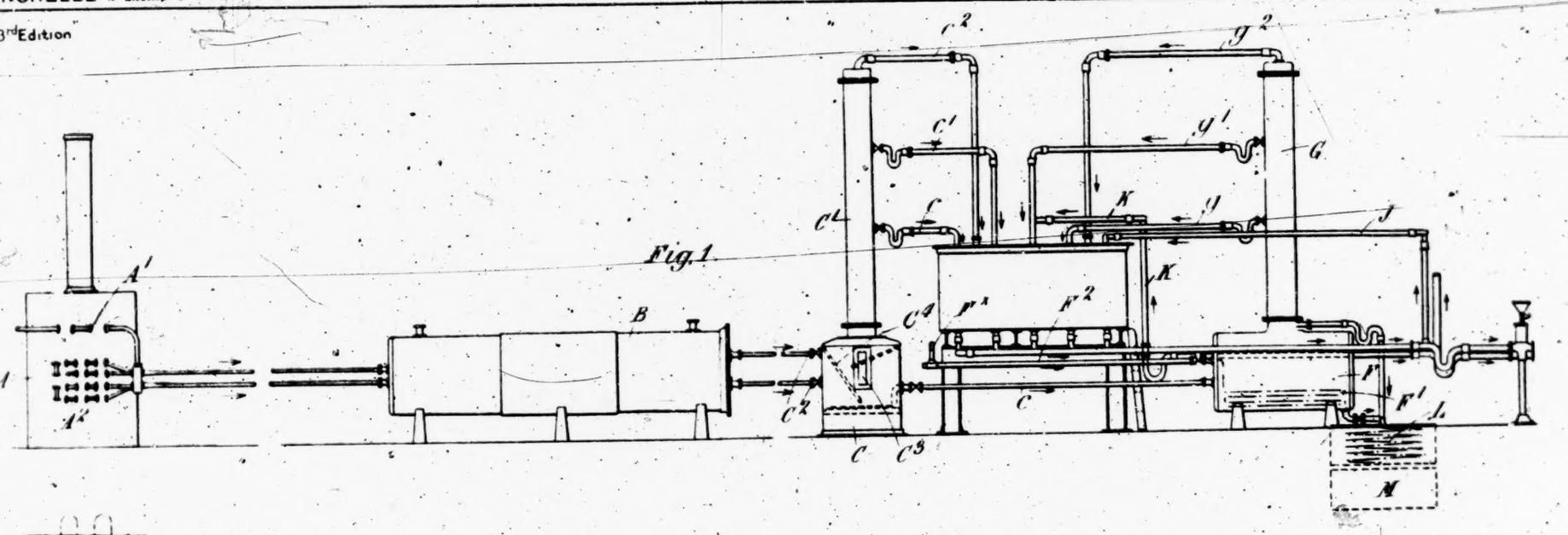
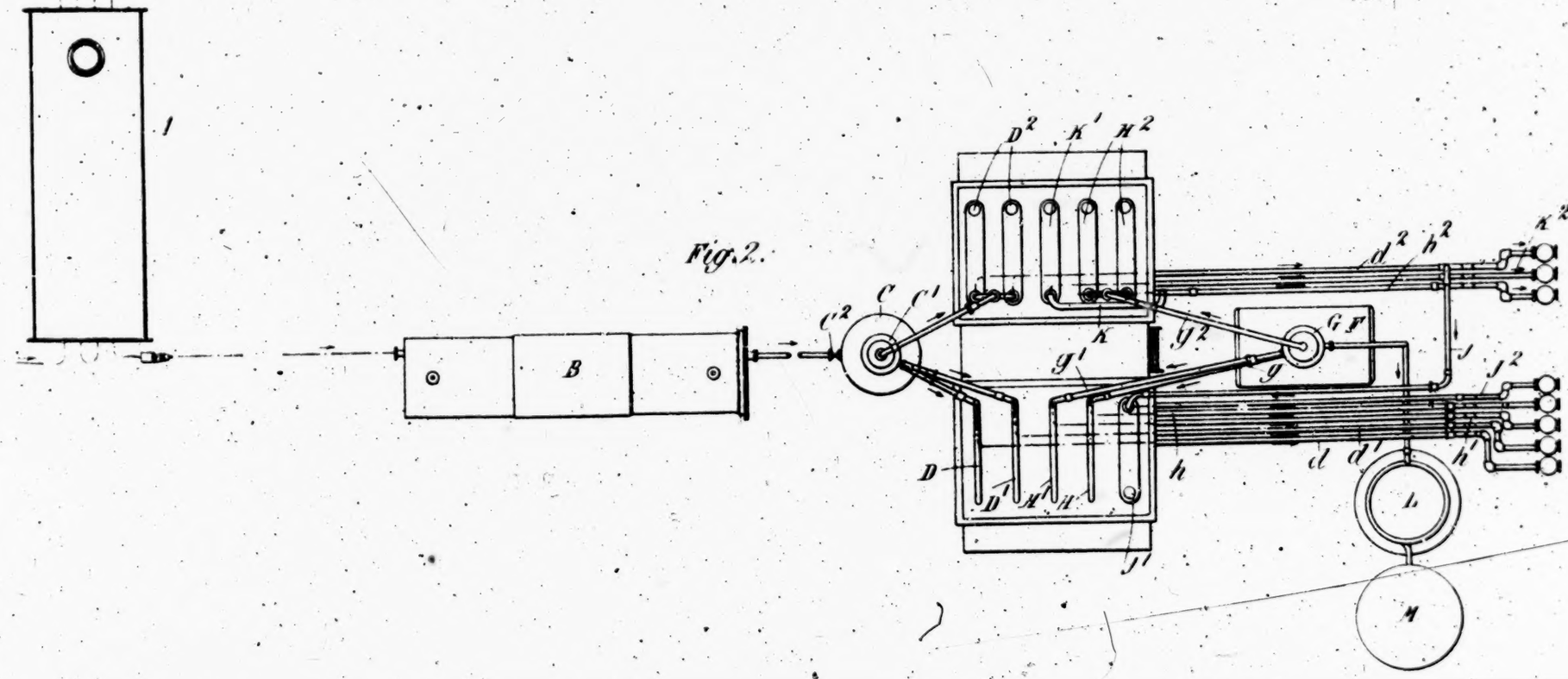


Fig. 2.



Charles & Read Ltd. Photo Litho

N° 15,084 A.D. 1915

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Date of Application, 25th Oct., 1915—Accepted, 25th Oct., 1916

COMPLETE SPECIFICATION.

Process and Apparatus for Converting Heavy Petroleum Oils into Light Oils.

I, MILON JAMES TRUMBLE, of 1918, Santee Street, in the City of Los Angeles, State of California, United States of America, Chemist, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

The invention relates to the art of refining petroleum oils, and its principal object is to provide a process and apparatus by which petroleum oils of high specific gravity may be converted into oils of much lower specific gravity. There is at the present time a large production of oils of high specific gravity, hereinafter called heavy oils, and such oils are of much less commercial value than oils of low specific gravity, hereinafter called light oils. The process and apparatus described herein has been used on a large scale to convert heavy oils into light oils.

The conversion of heavy oils into light oils has been previously accomplished in a crude way by various methods, which are known in the art as "cracking" processes. Previous inventors have devised many forms of apparatus for craking oils. This they have sought to accomplish by heat, with or without pressure, in some cases using various catalytic agents such as nickel, alumina, *etc.* In some cases these processes may be stated to be continuous processes inasmuch as a continuous stream of oil has been passed through the apparatus without periodical stoppages. It has, for instance, been proposed to pass oil through an apparatus in which it is subjected to heat and an adjustable degree of pressure, the lighter products being led away whilst the heavy residue is returned to a tank containing a supply of oil to be treated. In another process the oil has been passed through a vaporiser and into a chamber in which it is subjected to a cracking heat. In this chamber the oil is split up into vapours and tar or residue. The tar or residue is removed from this chamber from time to time and is not allowed to circulate through the apparatus. The vapours are led to the base of a classifying condenser having outlets which carry off the more volatile vapours. Further oil for treatment enters at the top of the condenser and is progressively heated as it passes through by contact with the vapours, certain of which are condensed thereby and let back to the vaporising and heating apparatus.

The process described herein comprises the following important features.

First, the process described herein is a continuous one, in which a definite volume of heavy oil is maintained in rapid motion at a cracking temperature through apparatus forming a closed ring, light oil vapors being removed as fast as formed, and fresh oil being continually supplied to take the place of the vapors withdrawn so that the volume of oil in the closed ring is maintained practically constant. In actual operation in large refineries the apparatus described has demonstrated that it can operate over a long period, continuously converting large quantities of heavy oils into light oils.

Second, it provides an apparatus in which the actual volume of heated oil is

small, the large capacity of the apparatus being due to the high efficiency of the various parts. Where the ordinary form of cracking stills are used a large capacity can be economically obtained only by using large units, which, when running, contain a large quantity of oil heated to such a temperature that it will spontaneously ignite when released into the air. A leak or break in such a still will result in the ejection of large volumes of highly heated oil, which burns with great violence. This condition becomes more serious where the still is used under pressure. With the small volume of oil contained in the apparatus disclosed herein, such serious conflagrations cannot occur. The apparatus, therefore, combines large capacity with great safety.

Third, the oil contained in the closed ring described above is forced through the heating means at a high velocity. The heating means comprises a series of pipes suitably connected to form a single continuous heating coil. The oil enters the coil at a moderate velocity and as it passes through the coil large quantities of vapor are gradually produced therein. This vapor remains intimately mixed with the body of the oil, due to its rapid motion, forming a foam, which gradually increases in volume and consequently travels with an increasing velocity through the heating coil.

The high velocity of the oil in the closed ring produces several important results, among which the following may be mentioned:

(*a*) It results in a high efficiency of heat transference, enabling large quantities of heat to be transferred to the oil from a relatively small heating surface.

(*b*) It results in a very uniform heating of the foamy mixture of oil and vapors so that there is no danger of producing undesirable products by local overheating.

(*c*) It prevents the deposition of carbon or other solid or viscous materials on the interior of the heating coil, so that the apparatus cannot become clogged or the efficiency of the heating surface destroyed by such deposition.

(*d*) It prevents unequal heating of the heating coil, as all parts of the coil are uniformly cooled by the oil flowing therethrough. The uniform and moderate heating of the coil gives the apparatus a long life and results in great safety of operation.

Fourth, the apparatus disclosed herein is especially adapted to work under pressure. It is a well known fact that the character of the products obtained from petroleum oils by cracking is not only dependent on the temperature, but also to a very great degree on the pressure under which the cracking takes place. The heating coil being composed of pipes is well adapted to stand high pressures even when heated, and these pressures are readily controlled by an adjustable valve through which the heating coil discharges.

Fifth, the apparatus is especially adapted to maintain constant the conditions under which the oil circulates through the closed ring, and to maintain constant the composition of the oil and the percentage of solid matter carried therein. Solid substances may be contained in the oil introduced into the apparatus, and solid hydrocarbons or even free carbon may be formed in the apparatus. Such solid substances cannot be vaporized and it is important that the circulating oil be relieved of them at the same rate at which they are formed if the composition of the oil is to be maintained constant. This condition of equilibrium is maintained in the closed ring by a constant withdrawal of light vapors, a constant withdrawal of heavy oil and included solids, and a constant replacement of the volume so withdrawn by fresh oil. The heavy oil can be conveniently withdrawn from the bottom of a settling tank forming a portion of the closed ring.

In practice a very small flow of heavy oil through the relief pipe is sufficient to prevent undue accumulations of objectionable solids in the body of the circulating oil. For example, with California oils, on which the apparatus has been commercially operated, the amount of oil withdrawn through the relief pipe is less than five *per cent.* of the oil introduced through the make-up pump.

The apparatus described herein differs greatly in method of operation and

results from the ordinary forms of cracking stills. In such stills a constant character of product cannot be obtained as the condition of the oil in the still, and consequently the character of the product obtained, changes gradually as the process proceeds.

In the apparatus described herein the oil circulating in the closed ring is maintained under constant conditions of temperature, pressure and composition, so that the character of the product obtained is constant. However, the temperature, pressure and composition of the oil in the closed ring may each or all be varied so that the character of the product obtained can be varied within certain practical limits.

Sixth, the apparatus described herein is provided with means for fractionating the vapors taken off and for returning certain undesirable constituents thereof to the ring for retreatment. This is important as it may be undesirable, or even impossible, in the practical operation of the apparatus to regulate the conditions in the closed ring to such a degree that only the desired product is produced. It is especially easy to operate various forms of fractionating apparatus with the apparatus disclosed therein as the character of the vapors given off, and the rate of flow thereof, is constant. The fractionating apparatus can therefore be operated under certain constant conditions with a consequent large capacity and high efficiency.

In the drawings, which are for illustrative purposes only:

Figure 1 is a plan view showing a certain arrangement of apparatus which is adapted to carry on the process, a portion of the furnace being broken away to better illustrate the internal structure, and a portion only of the supply tank being shown.

Fig. 2 is an elevation of said apparatus, the supply tank being omitted.

Fig. 3 is a section on a plane represented by the line x^3—x^3 in Fig. 1, looking in the direction of the arrows.

Fig. 4 is a section on a plane represented by the line x^4—x^4 in Fig. 1, looking in the direction of the arrows.

Fig. 5 is a section on the plane represented by the line x^5—x^5 in Fig. 3, looking in the direction of the arrows.

Fig. 6 is a section on the plane represented by the line x^6—x^6 in Fig. 4, looking in the direction of the arrows.

Fig. 7 is a section on the plane represented by the line x^7—x^7 in Fig. 3, looking in the direction of the arrows.

Fig. 8 shows a schematic diagram illustrating the process in a simple form.

Fig. 9 shows a similar diagram illustrating a modification of the process.

In the following description the term crude oil is used to designate the oil to be treated. This may be a natural oil in its raw state or it may be the product of previous refining or other treatment.

The apparatus illustrated by the drawings consists of a heating coil 1, a vapor releaser 2, a settling tank 3, deflegmators 4, and a condenser 5. A circulating pump 6 delivers oil from the settling tank 3 to the coil 1, crude oil is delivered to the coil 1 from a tank 7 by a make-up pump 8, and heavy oil with its included solids is drawn from the settling tank 3 by a relief pump 9.

The heating coil 1 is placed in a furnace 10 and consists of a series of pipes 11 joined into a continuous coil by pipe fittings 12 and 13. An inlet tee 14 and an outlet elbow 15 are secured on either end of the coil 1. Oil burners 16 of any well known form extend into the furnace 10 being fed with fuel from a fuel supply pipe 17.

The vapor releaser 2 may be of any suitable form. The form shown consists of a shell 18 having secured thereto a top 19 and a conical bottom 20. A hot mixture pipe 21 discharges through the top 19, being connected to a pressure control valve 22, which is connected to the elbow 15. Deflecting cones 23 are secured on pipe members 24, which are connected by tees 25 to vapor outlet pipes 26. The vapor outlet pipes 26 pass through the shell 18, a tight joint

therewith being insured by flanges 27. The cones 23 are of such a diameter that a small annular space is left between their outer edge and the inner wall of the shell 18. The pipe members 24 have perforations 28 cut therein. The vapor releaser may be heat insulated by proper covering material, or preferably it may be supported in a stack 29, as shown, being partially heat insulated by the use of a fire brick wall which surrounds it. An opening 30 connects the lower part of the stack with the interior of the furnace 10. An annular space 31 allows hot gases to ascend between the vapor releaser 2 and the wall of the stack.

The settling tank 3 illustrated consists of a shell 32 having a tight top 33 and a conical bottom 34. A residuum outlet pipe 35 connects the bottom 20 of the releaser 2 with the top 33 of the settling tank 3. A series of perforated deflecting and mixing cones 36 may be located in the settling tank 3 is desired. Pet cocks 37 allow the height of liquid in the settling tank to be readily determined. The settling tank may have heat insulation 38 applied thereto. If desired the settling tank 3 may be dispensed with, the bottom of the vapor releaser 2 being utilized as a settling tank. For clearness in description the settling tank is shown as a separate piece of apparatus.

An outlet opening 39 is provided in the side of the tank 3, a pipe 40 connecting this outlet with the circulating pump 6. A pipe 41 connects the pump 6 with the inlet tee 14, to which is also connected the crude oil inlet pipe 42, which is fed from the tank 7 through a pipe 43 and the make up pump 8. A relief pipe 44 connects the relief pump 9 to the conical bottom 34 of the settling tank 3.

A vapor column 45 connects the vapor outlet pipes 26 to the lower portion of the first of the deflegmators 4. The deflegmators may be of any of the well known forms, those illustrated consisting of a shell 46 having a tight cover 47 and a conical bottom 48. A series of condensation plates 49 extend across the interior of the shell 46, having openings 50 formed therein, the openings 50 having a raised lip 51 so that condensates can collect on top of each plate 49, the openings 50 in the different plates being staggered with relation to each other. The top portion of the first deflegmator is connected to the bottom of the second deflegmator by a pipe 52.

Any form of condenser 5 may be used. That illustrated consists of a shell 53 having tight ends 54 and inner heads 55 which divide the interior of the shell into a water inlet space 56, an oil space 57 and a water outlet space 58. Tubes 59 are tightly secured in the heads 55 connecting the spaces 56 and 58 and extending through the space 57. A vapor inlet fitting 60 opens into the top of the space 57 and a distillate outlet fitting 61 delivers light distillate to a pipe 62 from the bottom of that space. Water is supplied to the spaces 56 and 58 and to the interior of the tubes 59 by a water inlet pipe 63, this water being discharged through a water outlet pipe 64. The top portion of the last deflegmator 4 is connected to the vapor inlet fitting 60 through a pipe 65. A distillate discharge pipe 66 connects to the lower end of the conical bottom 48 of the first deflegmator 4, and a similar pipe 67 is similarly connected to the second deflegmator 4. The pipe 67 may be connected with a distillate return pipe 68 through a valve 69, and pipe 67 may also be connected to the pipe 68 through a valve 70. The pipe 66 may also be connected to a heavy distillate discharge pipe 71 through a valve 72, and the pipe 67 may be connected to a medium distillate discharge pipe 73 through a valve 74. The fuel supply pipe 17 connects into a tee 75, to which are connected valve 76 and 77. A fuel pipe 78 connects into the valve 76 and a pipe 79 connects the valve 77 with a tee 80, into which is connected a valve 81, this valve being connected to a heavy oil discharge pipe 82. The tee 80 is connected to the pump 9 through a pipe 83

The method of operation of the apparatus is as follows;

Crude oil is pumped to the inlet tee 14 through the pipe 42 by the make-up pump 8, this oil being drawn through the pipe 43 from the tank 7. Oil from the inlet tee 14 flows through the pipes 11 and the fittings 12 and 13 to the

outlet elbow 15 and through the valve 22 to the pipe 21. It is discharged from the pipe 21 into the vapor releaser 2, flowing downwardly therethrough and through the pipe 35 into the settling tank 3. As soon as sufficient oil collects in the settling tank 3, which can be ascertained by the pet cocks 37, the circulating pump 6 is started and the oil is forced around the closed ring of apparatus consisting of the pipe 41, the pipes 11, fittings 12 and 13, the pipe 21, the vapor releaser 2, the pipe 35, the settling tank 3, the pipe 40 and the pump 6. The burners 16 are then lighted, oil being supplied from the pipe 17. The pipe 17 may be supplied with fuel through the pipe 78, the valve 76 being open and the valve 77 being closed, or the valves 76 and 81 may be closed and the valve 77 opened, in which case oil is fed into the pipe 17 through the valve 77 from the pipe 83, this oil being taken off from the settling tank 3 through the pipe 44 and the pump 9. When the oil taken off from the settling tank through the pipe 44 is not used for fuel purposes, the valve 77 may be closed and the valve 81 opened, in which case the oil is delivered to suitable tankage not shown through the pipe 82. The flame and hot gases of the burners 16 play against the pipes 11 of the heating coil 1 and escape through the opening 30 into the stack 29, where they ascend through the annular space 31 between the shell 18 and the inner wall of the stack. The oil in the closed ring is rapidly heated, and as it enters the vapor releaser 2 is spread in a thin film over the inner walls of the shell 18 by the cones 23, the vapors escaping from the film passing through the openings 28 into the pipes 24 and through the vapor outlet pipes 26 into the vapor column 45. The further course of the vapors will be set forth hereinafter.

As the oil circulates through the closed ring of apparatus above defined, vapors are continually removed by the vapor releaser and sufficient crude oil is constantly injected by the make-up pump 8 to maintain a constant volume of oil in the apparatus. The entering crude oil may contain carbon, solid hydrocarbons, sand, silt or other foreign matter. It may also contain liquids that will not be vaporized or cracked at the operating temperature of the apparatus. All of these substances, as well as any similar substances formed in the oil in its circulation through the closed ring, must, therefore, remain in the oil after it has passed through the vapor releaser 2, and unless some means were provided to dispose of them, must eventually choke the closed ring or at least render the oil in it of such a character that little evaporation or cracking could take place therefrom.

To relieve this condition, a small quantity of oil is constantly withdrawn from the extreme bottom of the settling tank 3 this material being conveniently disposed of by feeding it by means of the pump 9 and the pipe 17 to the burners 16, where it is readily burned. The oil being somewhat reduced in velocity in passing through the settling tank, any material that will settle anywhere in the closed ring will settle to the bottom of the tank. It is not, however, necessary to provide such a settling tank, as the heavy oil may be removed from the bottom of the vapor releaser or, indeed, anywhere between the vapor releaser and the inlet to the heating coil.

The oil enters the heating coil 1 at a moderate velocity and is practically free from vapor. As it circulates through the heating coil a portion thereof is broken up to form a lighter hydrocarbon, the small globules of light vapor being swept on by the moving mass of oil which assumes a foamy nature. This foam greatly increases the volume of the flowing stream, which therefore accelerates rapidly. The movement of the oil and vaper through the heating coils is sufficiently rapid to provide high efficiency of heat transfer between the interior of the pipes 11 and the oil, to uniformly heat the oil and vapors, so that none of it is subjected to excessive temperatures, to prevent any deposits of solid or viscous material on the interior of the pipes 11, and to prevent local overheating anywhere in the coil 1, so that the coil has a long life and is very safe to operate. The foam remains in the heating coil 1 only a very short time, being immediately passed into the vapor releaser 2, where the vapors are withdrawn from the oil

This is important, as there is some danger of the vapors being further cracked if retained in the heating coil.

When operating with some sorts of crude oil, it is necessary to put some pressure on the oil in the heating coil 1 to produce a desired product. This can be readily done by partially closing the valve 22.

In practical operation, the heat of the fire, the rate of injection of crude oil, the speed of the circulating pump, the rate of withdrawal through the relief pipe 44, and the pressure are all regulated so that the oil passing through the closed ring is subjected to a definite and constantly recurring cycle of conditions. It is of course obvious that there are limits within which the various factors can be practically controlled, and there are therefore practical limitations to the product that can be obtained by this process from a given oil. The product can, however, be very materially modified by a suitable modification of the conditions in the closed ring, and one great advantage of the present process is the ease with which conditions in the ring can be modified to produce the best commercial results.

The vapors in the vapor column 45 may be the desired product, in which case the deflegmators 4 can be dispensed with, the vapors being passed directly into the condenser 5, condensed therein and passed off through the pipe 62. It may, however, be desired to separate the product into distillates of several gravities, in which case the deflegmators are very convenient.

The vapor passes from the vapor column 45 to the bottom of the first deflegmator and through a tortuous course through the openings 50 to the top. The vapors then pass through the pipe 52 to the second deflegmator and through the openings 50 to the top thereof. The vapors in passing through the deflegmators are gradually cooled, a heavy distillate collecting on the plates 49 and running over the lips 51 into the bottom of the first deflegmator. A medium distillate condenses and collects in the second deflegmator. The vapors not condensed in the deflegmators are condensed in the condenser 5 to form a light distillate, which is delivered through the pipe 62. The heavy distillate may be a desirable commercial product, in which case the valve 69 is closed and the valve 72 is opened, the heavy distillate being delivered after cooling through the pipe 71 to suitable tankage. If the heavy distillate is not a desirable commercial product, the valve 72 may be closed and the valve 69 opened, the heavy distillate being delivered to the pipe 68. If the medium distillate delivered by the pipe 67 is a desirable commercial product, the valve 70 is closed and the valve 74 is opened, the medium distillate being delivered after cooling to suitable tankage through the pipe 73. If this medium distillate is not a desirable commercial product, by opening the valve 70 and closing the valve 74, medium distillate can be delivered to the pipe 68. Any distillate delivered to the pipe 68 is returned to the settling tank 3, being delivered onto the mixing plates 36, where it mixes with oil delivered from the vapor releaser 2 through the pipe 35, thereby being reintroduced into the closed ring for retreatment.

It will be seen that the invention includes the following important features.

First, the forcing of petroleum oils through a heating coil, heated to a sufficient degree to crack the oil, at such a rate and at such a pressure that the oil can be changed into a foam without danger of unduly heating portions thereof or burning the coil, it having been found by the inventor that heavy petroleum oils are changed to light ones by such a process.

Second, the immediate release of the foam so produced, the removal of vapors therefrom and the immediate recirculation and reheating of the oil to form more foam, the oil being kept in continuous motion over a closed ring or path.

Third, the condensation of a portion of the vapors so produced, and the return to the closed ring of the distillate so produced.

Fourth, the use of the settling tank 3 in a closed ring and the continuous removal of heavy oil and foreign matter from the bottom of this tank, so that

accumulations of solid matter in the ring is prevented and the composition of the oil in the closed ring is maintained constant.

Fifth, the use of the make-up pump 8 for the purpose of maintaining constant the volume of the closed ring as vapors and heavy oil with included sediments are taken off therefrom.

Sixth, the use as fuel in the burners 16 of the hot, heavy oil from the bottom of the tank 3.

Having now particularly described and ascertained the nature of my said invention and in what manner the same is to be performed, I declare that what I claim is:—

1. The process of craking petroleum oils by continuously injecting same into a ring of heavy liquid residuum, a portion of which is maintained at a temperature sufficient to vapourise and crack the oil under treatment, said ring including a device for continuously releasing the lighter vapours.

2. The process according to Claim 1 wherein the closed ring is continuously relieved of a small amount of heavy oil and continuously supplied with fresh oil in sufficient quantity to maintain constant the volume of oil in the closed ring.

3. The process according to Claim 1 or 2 wherein a cracking pressure is maintained in the heated portion of the closed ring.

4. An apparatus for converting heavy petroleum mixtures into light petroleum oils comprising a primary heating means, a vapour releaser, means for conducting the heated mixture from the primary heating means to the vapour releaser, means for withdrawing light vapours from the vapour releaser, means for forcing the residuum from the vapour releaser through the primary heating means, and means for injecting sufficient fresh heavy oil into the residuum from the vapour releaser as it enters the heating means, to maintain the volume of oil in the apparatus approximately constant.

5. Apparatus according to Claim 4 wherein means is provided for continuously withdrawing a portion of the residue.

6. Apparatus according to Claim 4 or 5 wherein means is provided for condensing a portion of the light vapours withdrawn from the vapour releaser and for injecting said condensed vapours into the residuum as it returns to the heating means.

7. In apparatus according to Claim 4 a settling tank for the residuum from the vapour releaser, substantially as described with reference to Fig. 4 of the accompanying drawings.

8. The improved process and apparatus for converting heavy petroleum oils into light oils substantially as hereinbefore described.

Dated this 25th day of October, 1915.

HAROLD J. C. FORRESTER,
Fellow of the Chartered Institute of Patent Agents,
Jessel Chambers, 88—90, Chancery Lane, London, W.C., and
Central House, 75, New Street, Birmingham,
Agent for the Applicant.

Redhill: Printed for His Majesty's Stationery Office, by Love & Malcomson, Ltd.—1916.

[This Drawing is a reproduction of the Original on a reduced scale.]

Fig. 1.

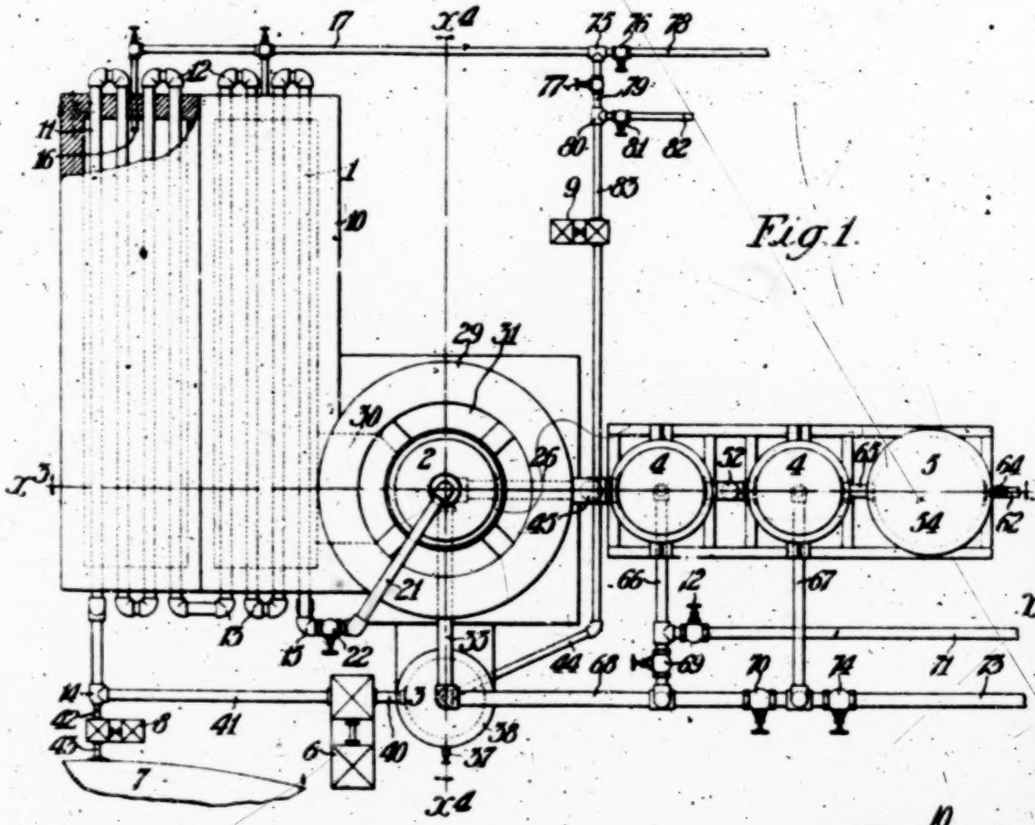

Fig. 6.

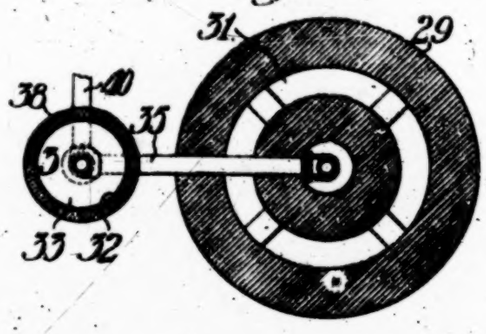

Fig. 5.

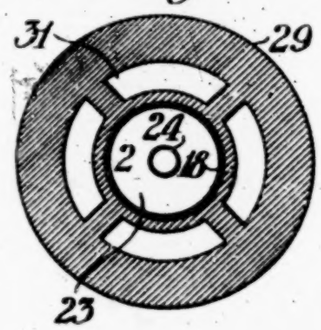

Fig. 3.

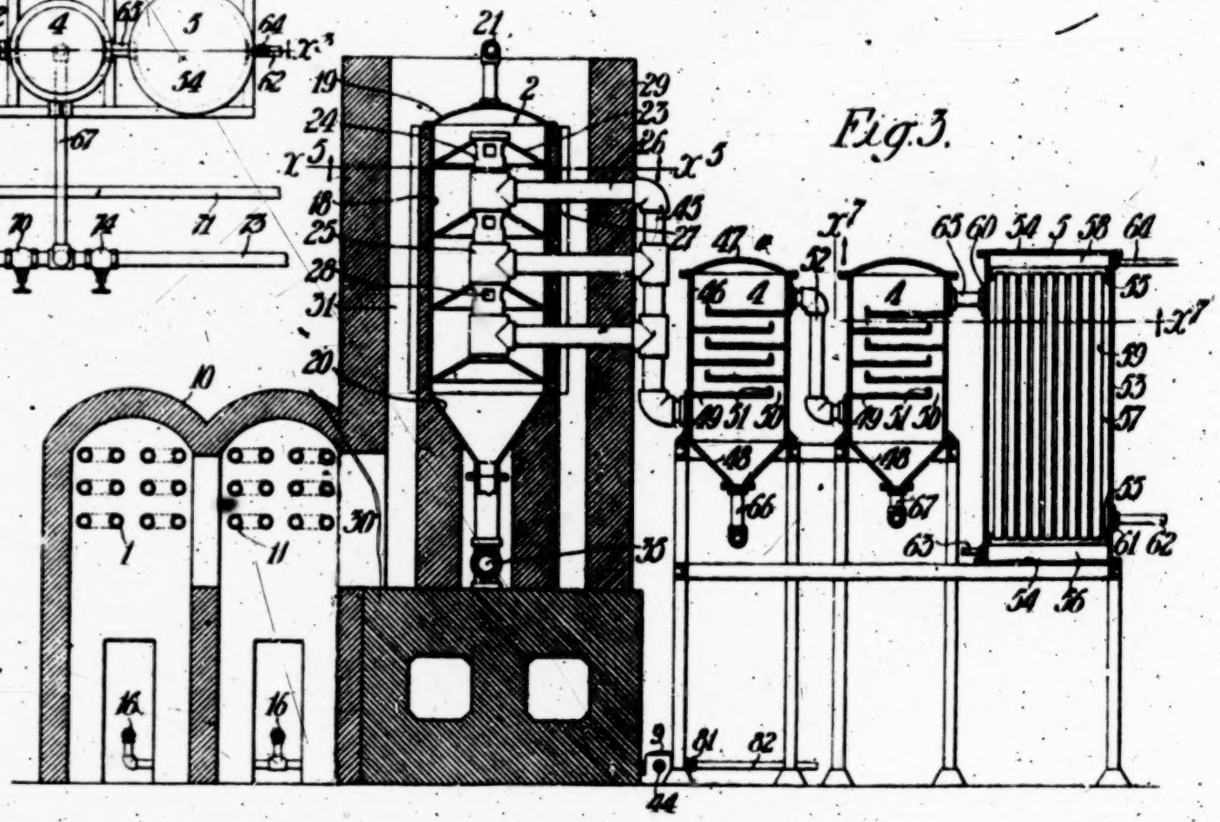

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Fig. 4.

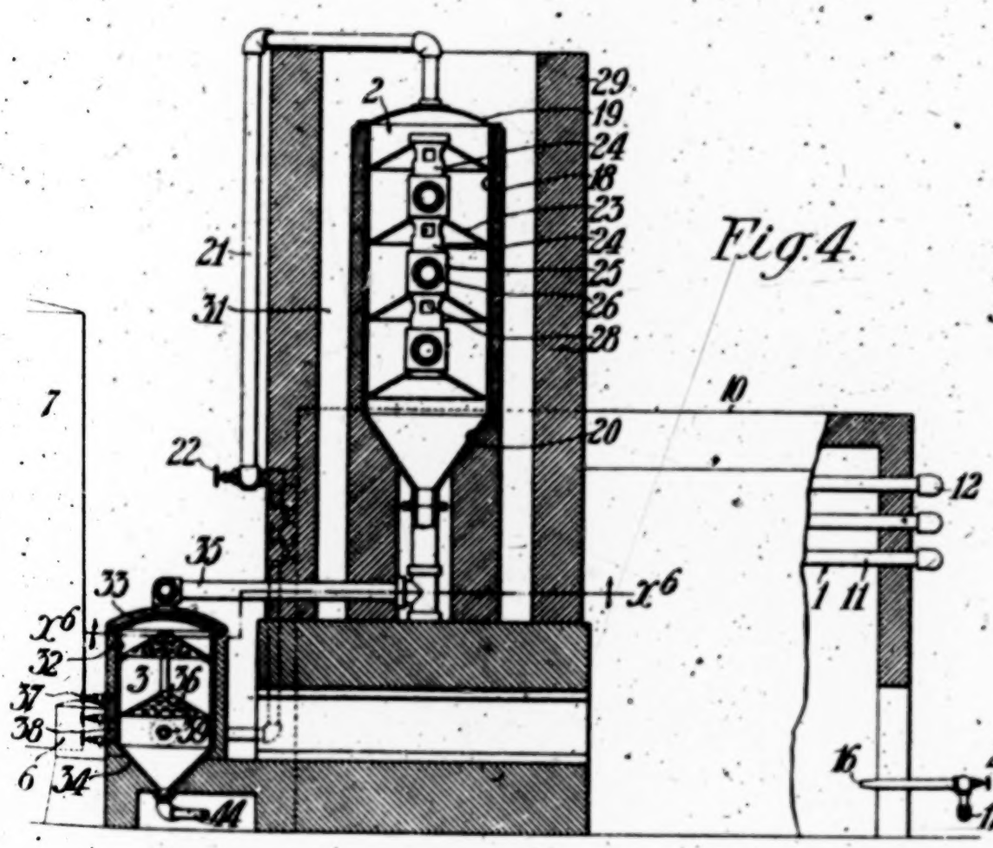


Fig. 7.

Fig. 8.

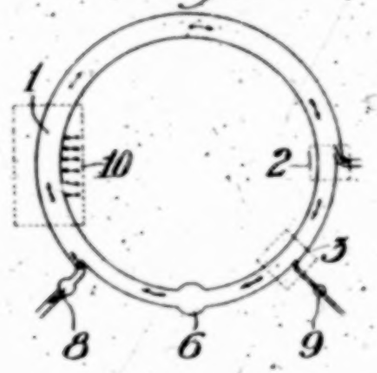


Fig. 2.

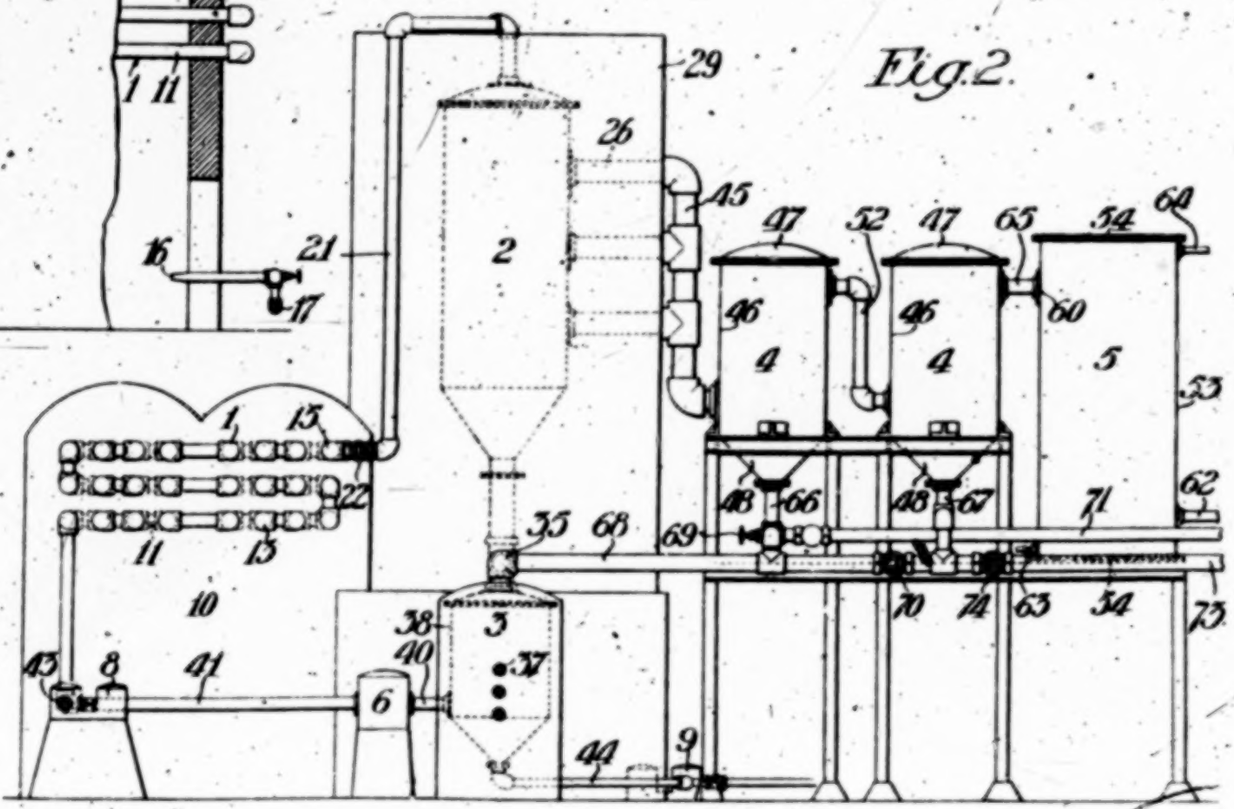
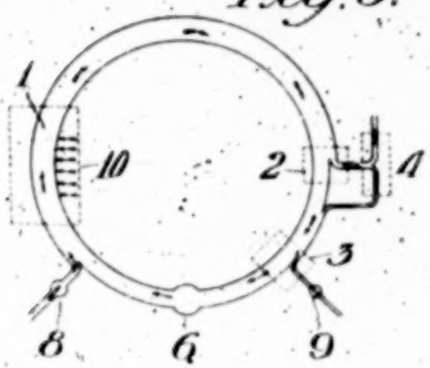


Fig. 9.



Malby & Sons, Photo-Litho.

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

I, Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing printed pages contain a true copy of Volume 7 of the printed record, printed under my supervision, which, together with Volumes 1 to 6, inclusive, constitutes the record upon which the following entitled cause was heard and determined:

Cause No. 7912.

Universal Oil Products Company,
Plaintiff-Appellant,

vs.

Globe Oil & Refining Company,
Defendant-Appellee,

as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In Testimony Whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this 18th day of August, A. D. 1943.

(Seal)

Kenneth J. Carrick,
Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

At a regular term of the United States Circuit Court of Appeals for the Seventh Circuit, held in the City of Chicago, and begun on the sixth day of October, in the year of our Lord one thousand nine hundred and forty-two, and of our Independence the one hundred and sixty-seventh.

Universal Oil Products Company,
Plaintiff-Appellant,
No. 7912 *vs.*
Globe Oil & Refining Company,
Defendant-Appellee.

Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

And, to-wit: On the fourteenth day of January, 1942, there was filed in the office of the Clerk of this Court, an appearance of counsel for Plaintiff-Appellant, which said appearance is in the words and figures following, to-wit:

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

Cause No. 7912.

Universal Oil Products Company,
Plaintiff-Appellant,

vs.

Globe Oil & Refining Company,
Defendant-Appellee.

The Clerk will enter our appearance as counsel for Plaintiff-Appellant.

A. F. Reichmann,
231 So. La Salle St.,
Chicago, Illinois.
Thomas G. Haight,
15 Exchange Place,
Jersey City, N. J.
William F. Hall,
Victor Bldg.,
Washington, D. C.
Walter T. Blenko,
Farmers Bank Bldg.,
Pittsburgh, Pa.
Charles M. Thomas,
Shoreham Bldg.,
Washington, D. C.

Endorsed: Filed January 14, 1942. Kenneth J. Carrick, Clerk.

And afterwards, to-wit: On the nineteenth day of January, 1942, there was filed in the office of the Clerk of this Court, an appearance of counsel for Defendant-Appellee, which said appearance is in the words and figures following, to-wit:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

No. 7912.

Universal Oil Products Company,
Plaintiff-Appellant,

vs.

Globe Oil & Refining Company,
Defendant-Appellee.

The Clerk will enter our appearance as counsel for the Defendant-Appellee, Globe Oil & Refining Company.

J. Bernhard Thiess,
Thorley von Holst,
Sidney Newman,
Robert W. Poore,
77 W. Washington Street,
Chicago, Illinois.

January 17, 1942.

Endorsed: Filed January 19, 1942. Kenneth J. Carrick, Clerk.

And afterwards, to-wit: On the third day of May, 1943, the following further proceedings were had and entered of record, to-wit:

Monday, May 3, 1943.

Court met pursuant to adjournment.

Before:

Hon. Evan A. Evans, Circuit Judge.
Hon. J. Earl Major, Circuit Judge.
Hon. Walter C. Lindley, District Judge.

Universal Oil Products Company,
Plaintiff-Appellant,
No. 7912 *vs.*
Globe Oil & Refining Company,
Defendant-Appellee.

Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

Now this day come the parties by their counsel, and this cause comes on to be heard on the transcript of the record and the briefs of counsel, and on oral argument by Mr. William F. Hall, counsel for appellant, and by Mr. Thorley Von Holst and Mr. J. Bernard Thiess, counsel for appellee, and the court takes this matter under advisement.

And afterwards, to-wit: On the thirtieth day of June, 1943, there was filed in the office of the Clerk of this Court, the Opinion of the Court, which said Opinion is in the words and figures following, to-wit:

IN THE UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

No. 7912. **October Term, 1942, April Session, 1943.**

UNIVERSAL OIL PRODUCTS COMPANY, *Plaintiff-Appellant,*
vs.
GLOBE OIL & REFINING COMPANY, *Defendant-Appellee.*

Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

June 30, 1943.

Before EVANS and MAJOR, *Circuit Judges,* and LINDLEY, *District Judge.*

EVANS, *Circuit Judge.* Plaintiff brought suit on two patents, one to Carbon P. Dubbs, No. 1,392,629, issued October 4, 1921, and the other, No. 1,537,593, issued to Gustav Egloff, May 12, 1925.

Defendant challenged the validity of both patents and denied infringement of either patent. It also vigorously contends that plaintiff's conduct necessitated a denial of all relief by a court of equity because of Dubbs' unethical conduct. It invokes the plaintiff's unclean hands as its third defense.

The court held the Dubbs patent to be valid, but not infringed, and declared the Egloff patent, invalid. As to the defense of unclean hands, the court reached the conclusion that "there was no conduct on the part of plaintiff proven in this case which should bar plaintiff from maintaining this action," etc.

While defendant insists that the Dubbs patent is invalid and that plaintiff was guilty of subornation of perjury in the interference suit which resulted in the allowance of the Dubbs patent, we will discuss only the question of infringement of the Dubbs patent. On this issue as to this patent we agree with the District Court. It is unnecessary therefore to decide the other two questions, so elaborately and ably argued by opposing counsel.

The District Court made careful and complete findings upon each issue and filed an excellent opinion on this vital question of noninfringement. We set forth in the margin extracts from this opinion.*

Counsel and the lower court both give more serious consideration to the Dubbs patent than to the Egloff patent. The latter might be described as an improvement over the former. The Dubbs patent is represented by nine process claims. Speaking from the application, it may be said:

> "This invention relates to improvements in processes of converting hydrocarbons and refers more particularly to an improved form of cracking process of the continuous type. Among the salient objects of the invention are to provide a process in which the

* "In his process Dubbs treats crude oil while in the Burton and Burton-Clark stills only gas oil (a lighter oil obtained from crude petroleum by distillation) could be used. The material to be treated is pumped into a nest of 4 inch tubes known as B tubes and during the time it is passing through said tubes they are subjected to sufficient heat to cause the desired amount of cracking. The oil is then passed into ten inch tubes designated as C tubes where vapor is liberated. This liberated vapor passes to an aerial condenser. The uncondensed vapor is passed on to other condensers. The vapor condensed in the aerial condenser is returned by gravity to the heating zone where, with the fresh feed, it is again subjected to cracking temperature. The residue in the C tubes is continually drawn off from those tubes. Pressure is maintained throughout the apparatus by means of a regulating valve. • •

"Defendant's process is essentially as follows: A fairly clean distillate is fed in a steam to cracking coils and subjected to temperatures up to 940 degrees F. and pressures of 500 pounds. As this stream leaves the cracking coils, it is passed through a valve by which the pressure is reduced to 26 pounds. Then a second stream is conducted into the first, this second stream consisting of topped crude oil from a low pressure furnace. The merged stream is conducted into a 'vaporizing chamber' (as plaintiff calls it) or 'vapor separator' (as defendant calls it) where the vapors from the cracked stream pass out through the top into a bubble tower where partial condensation takes place, and from the top of which the vapors pass to a final condenser. The liquid residue which collects in the bottom of the vaporizing chamber, to use plaintiff's terminology, is drawn off and run to storage facilities. This residue is never re-cycled through the cracking tubes. The reflux liquefied in the bubble tower is re-cycled through the cracking tubes."

oil is continuously fed through the cracking zone and thence through the vapor zone, and a portion of the generated vapors condensed and returned to the inlet side of the cracking zone for further treatment; to provide a process of the character above referred to in which the carbon containing residue is continuously removed from the cracking zone while the reflux condensate is returned to the cracking zone for further treatment substantially free from carbon; to provide a process which permits of the apparatus being operated for an extended period without the necessity of cleaning and in which that part of the system containing the precipitated carbon, is free from subjection to any excessive heat; to provide a process in which the reflux condensate is continuously removed from the refluxing condensing apparatus and returned to the inlet side of the system; to provide a process in which the vapors not initially condensed are finally caused to pass through a single passage for a secondary condensing action and in general to provide an improved process and also a novel apparatus of the character referred to."

Claim 7 is a typical one, and reads:

"7. A process of cracking oil consisting in continuously passing a stream of oil through a series of tubes seated in a cracking zone where the oil is heated to the cracking temperature but substantial vaporization prevented, and thence to an enlarged vapor chamber where vaporization takes place, removing the vapors from said chamber, subjecting them to an initial condenser where a portion of the vapors are condensed, subjecting the uncondensed portion of the vapors to a final condensation, returning the condensate from said initial condensation to the inlet side of the cracking tubes and continuously drawing off the residue from the vapor chamber and preventing it from returning to the cracking zone and maintaining a pressure on the oil during treatment."

The so-called "cracking process" as applied to the gasoline production art was old when Dubbs entered the field. The chemists in the college laboratories had long previously made the discovery that heat applied to oil, crude and refined, resulted in the molecules' cracking. Out of this

heating of the oils ultimately came gasoline. This fact information was old and well known in the trade engaged in gas production.

Likewise, and we here more nearly approach the art in which Dubbs worked, there had been variously devised apparatus to commercially practice that which had been taught in the chemist's laboratory. As in many instances there was a giant step from the teachings of the laboratory to the production of gasoline by cracking on a commercial basis. It was a step so necessary and yet hard to take, where theory was converted into the practical, where a scientific discovery became a usable commercial process.

The need for gasoline was great. Yet there was a maximum price beyond which the producer could hardly go. The production of more gas from the given amount of crude oil was desirable, but only if the price at which it was produced made its use possible. The task therefore was to devise a means whereby more gasoline could be produced by the cracking process and the cost thereof kept down through production on a large scale basis. Large were the inducements for success and numerous were the operators in the field. Many different kinds of apparatus were devised and many were in use. Success was a relative term. The fact significant to us is that the field was far from a virgin one when Dubbs entered. It was more completely occupied when Egloff approached it, viewed it, and then entered it.

The practice common to all was to use large retainers, apply heat as economically as possible and keep the oil continuously moving in pipes of sizes, shape, turns, etc., as the designer deemed wisest.

The District Court described the first commercial success process devised by Dr. Barton in 1912 so well that we quote therefrom:

> "Petroleum as it comes from the ground contains a variety of compounds composed of hydro carbon molecules, the various molecules being composed of atoms of hydrogen and carbon differently arranged and with differing numbers of carbon and hydrogen atoms. Many years ago it was discovered that by the application of heat some of these molecules could be broken up, some of the heavier carbon atoms separated from lighter hydrogen atoms and a lighter oil having a

lower boiling point was produced. This process is known in the art as 'cracking.'

"With the development and increased use of the internal combustion engine came a greatly increased demand for the lighter oil known as gasoline. This fluid was recoverable from crude petroleum by a simple process of distillation and this method had been used for years, but the amount so produced was insufficient to meet the needs of modern industry. It was known that gasoline could be produced from the heavier oils by cracking and various inventors had been exploring the possibilities of so producing gasoline in commercial quantities.

"The first practical process, the first that met with commercial success, was devised by Dr. Burton and put into operation during the year 1912. In his process about 8250 gallons of light oil which had theretofore been obtained from crude petroleum by distillation was put into a shell eight feet in diameter and thirty-two feet long. From that shell two vapor lines, each about 12 inches in diameter and 35 feet long led to a condenser. A fire was built under the shell and the liquid therein heated to a temperature of from 700° F. to 750° F. and became subject to autogenous pressure of about 75 pounds from the vapors and non-condensible gases produced by the heating. This temperature and pressure were maintained throughout the operation. The vapors generated passed up through the vapor tubes where they were subjected to partial condensation. The portion of the vapor condensed, termed reflux condensate, returned through the long vapor line to the shell where it was subjected to further cracking. The uncondensed vapor was passed on from the partial condensation chamber for further processing.

"About twelve hours were required to bring the contents of the shell to the proper temperature and pressure, to bring the still 'on stream.' It remained 'on stream' about 24 hours when it became necessary to draw the fires and withdraw the oil remaining in the still and remove the carbonaceous material which had been released during the operation and had adhered to the inner wall. This required about 12 hours.

> "This method had several disadvantages. A still could be 'on stream' only about 24 out of every 48 hours. Only about 28% of the total charge was recoverable as gasoline. The 'on stream' period was necessarily limited to 24 hours because experience had shown that the carbonaceous material accumulating on the bottom of the shell retarded the absorption of the heat by the oil, and caused 'hot spots' to appear on the shell. If the 'on stream' period were extended an explosion was likely to occur at these 'hot spots' with serious danger to the life of those operating the still and great property damage as well. Several such explosions had occurred."

Determination of the issue of infringement in the District Court turned largely upon the meaning of the language of one step of the claim—"but substantial *vaporization prevented.*" Appellant contends that the District Court erred because it failed to give the proper definition to the word "vaporization," as here used.

Plaintiff's right to define the terms used in its patent is clear. Its language and its meaning of the words selected, govern. This is the generally accepted view of the courts, including this court, in construing the language used by the inventor in describing his invention. *Dennis* v. *Pitner*, 106 F. 2d. 142; *Northwest Eng. Co.* v. *Keystone Driller Co.*, 70 F. 2d. 13; *Rajah Auto Co.* v. *Belvidere Co.*, 275 Fed. 761; *Advance Rumley Co.* v. *John Larson Co.*, 275 Fed. 249.

Equally clear is the rule that words will be given their ordinary and accustomed meaning unless it appears that the inventor used them differently. Moreover, the meaning which the inventor gives to his words can not be made to depend upon subsequent events, but should appear when the application is filed. For example, an applicant who used words of common meaning and finds they do not cover a subsequently created structure will not be permitted to place a new or different meaning that will cover said subsequently appearing structure. The District Court believed this was what Dubbs tried to do in this case. He tried to give a new meaning to the word "vaporization" in order to cover the defendant's structure after it became apparent that the ordinary meaning of the language of the patent would not cover defendant's structure.

The word "vaporization" is not difficult of definition. Even in the absence of authority, it would seem clear that

it was the act of vaporizing. Only one meaning would ordinarily be given to the expression "but substantial vaporization *prevented.*" Dictionaries, lexicographers, and textbooks* have, however, defined the term and always in harmony with that general meaning of "act of vaporizing." Webster says:

> "Act or process of vaporizing, or state of being vaporized; artificial formation of vapor; specif., conversion of water into steam, as in a steam boiler."

Funk & Wagnall states the definition:

> "The act or process of vaporizing, or the state of being vaporized."

Encyclopedia Britannica:

> "Vaporization, a general term denoting the change of state of any substance from solid or liquid to vapour."

Columbia Encyclopedia:

> "Vaporization is concerned with the change of a substance into a gas or vapor."

Oxford Dictionary:

> "The action or process of converting, or of being converted, into vapour."

The Encyclopaedic Dictionary:

> "Vaporization, The act or process of vaporizing; the artificial formation of vapour; the state of being vaporized."

The Century Dictionary and Cyclopedia:

> "Vaporization. The act or process of vaporizing; the formation of vapor, or the state of being converted into vapor; treatment with vapor."

We are satisfied to adopt that part of Judge Holly's opinion (40 F. Supp. 581) which deals with infringement of the Dubbs patent. It so fully and satisfactorily states

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* Carhart, Physics for College Students, p. 375; Spinney, A Textbook of Physics, p. 196; Barker, Physics, Advanced Course, p. 309; Herring, Essentials of Physics for College Students, p. 115; Shrader, Physics for Students of Applied Science, pp. 198, 202; Norris, A Textbook of Inorganic Chemistry, p. 163; Ferry, General Physics and Its Application to Industry, p. 268; Encyclopaedia Britannica, Vol. 22, p. 979; First Principles of Physical Science, Wells, p. 194; Atkinson, Elementary Treatise on Physics, p. 278; Reed, College Physics, p. 240; Coleman, The Elements of Physics, p. 192; Anderson, Mechanics and Heat, p. 260; Walker, Principles of Chemical Engineering, p. 381, 478.

and disposes of this issue that we believe further discussion unnecessary and inappropriate. We will confine ourselves to briefly stating added reasons for the conclusion thus reached.

In appraising Dubbs' invention and assuming its validity, there are several factors which need be stressed in defining its limitations.

(a) The claims of plaintiff's patent, not his invention, or what is now claimed to be his invention, govern.

(b) The claims cover a process—not a product. Confusion may be avoided by keeping in mind the steps described which can not be liberalized or helped by the drawings of an apparatus and which might have been the basis of product claims.

(c) The art here involved was built upon an established scientific fact, well known long prior to the time Dubbs entered the field, namely, that heat would crack molecules of oil. The field of discovery was well occupied. It was limited to processes, whereby heat was applied to moving oil, which would more economically and safely produce gasoline. At best the invention was in the nature of an improvement and the language of the claims should be construed accordingly.

(d) The word "prevented" in the phrase "by substantial vaporization prevented" is significant. Even though the word be used relatively rather than absolutely, it is, we think, highly significant in comparing defendant's process and apparatus with plaintiff's. It points to the heart of a vital step in the Dubbs' process. In defendant's process, accuracy would require a description which said, instead of "prevented," there was an encouragement, or at least no prevention, of vaporization. And this is so no matter what meaning is given to the word "vaporization."

In construing a process claim, attention is directed to the verb. It described the step. In this case the verb is "prevent." What is "prevented"? Vaporization.

Even if we accept plaintiff's definition of vaporization, still defendant did not provide an apparatus that *prevents* substantial vaporization. The apparatus used by both parties calls for what the expert witnesses termed tubes (called by counsel, cracking (B) tubes and vaporization (C) tubes). Plaintiff heats its oil in B tubes to the cracking temperature. Its oil then passes to the mildly or un-

heated C tube where vaporization as plaintiff defines that term, occurs. In defendant's apparatus, the oil is cracked and vaporized in what might be called its B tubes, and this is so whether we accept plaintiff's or defendant's definition of vaporization.

Avoidance of this conclusion is possible only by finding the tubes which defendant called its B tubes are C tubes. We are not justified in so doing. The claims do not describe the tubes as B or C tubes. The claim is for a process, and therefore we have steps described. It is the actions which are stated in the separate steps that constitute the claim. Thus Dubbs describes one step as heating oil to the cracking temperature. He then modifies this by adding the all important phrase (without which the Patent Office rejection would have stood) "but substantial vaporization prevented." This action he accomplished (although he does not say so in his claim) by the use of different sized tubes and the application of heat and its withdrawal when the cracking point is reached.

Now the evidence is that oil can not be heated to the cracking point, which is different in different oils, without vaporization and in thus speaking, we accept plaintiff's definition of vaporization. But defendant's apparatus and its process not only heat to cracking point, but heat to a point where cracking and vaporization take place. In other words "substantial vaporization prevented," is the action which is the heart of this step of plaintiff's process, while defendant heats its oil to the cracking point, but does not stop there, making no effort to *prevent* vaporization.

Egloff patent. The District Court held this patent was invalid.

Defendant asserts it is a paper patent, has never been used, and in several respects lacks in inventive attributes.

We are not much impressed by the charge that it is a mere paper patent or that it has never been used. If merit lies in it, validity cannot be refused because of lack of use. Boycott by users or lack of means of the inventor sometimes accounts for the non-use of an invention. Moreover, it may get into hands not interested in exploiting it. The questions for decision are: What are the merits of the invention? and Does the patent fully and correctly describe the invention?

We are persuaded that defendant did not infringe the

claims of this patent. When Egloff entered the field it was less open than when Dubbs made his entrance. True, there is always room for one more and happily no art is ever closed. Unoccupied places may become narrower, but the inventor's contribution may be, and often is, just as outstanding and just as important and valuable as it would be if the field were a virgin one, and the invention the first to appear. In fact an invention in a crowded art may be like a fertilizer on exhausted soil. It gives new life to a dying industry.

On this phase of the case we are not adopting the District Court's opinion, nor are we disapproving of it. We rather choose to place our conclusion on the ground that there was no infringement. We can not escape the conclusion that Egloff was dealing with a decidedly different problem. Like Dubbs, his drawings and specifications both suggest a product patent. He says his invention relates to improvement in process and *apparatus* for cracking oil. Although he thus refers to apparatus, his claims do not support his reference. No apparatus is described. The drawings, however, help us to understand what Egloff was doing.

Even assuming validity, it is apparent that the Egloff process is at most a narrow patent limited strictly to the steps described. It is infringed only when such steps are taken as described. Defendant not only proceeds differently by its process but the differences are both additions and elimination of steps. We think elaborate discussion here would be of no interest to anyone save the parties. As to them we say, defendant, in its brief, has pointed out the distinctions between its process and the claims of the patent. Far from showing infringement, we think the record affirmatively and clearly shows, defendant's structure is far out of the reach of Egloff's disclosure. And in saying this we give considerable stretch to the disclosure of Egloff.

The decree is

AFFIRMED.

Judge Lindley agrees that the judgment should be affirmed. He is of the opinion, however, that affirmance should be on the ground that the Dubbs patent in suit was invalid because the prior art patents showed anticipation. He is also of the opinion that if the Dubbs patent is valid,

it is infringed by the Globe Oil & Refining Company process. As to the Egloff patent he is of the opinion that the same is invalid.

Endorsed: Filed June 30, 1943. Kenneth J. Carrick, Clerk.

And on the same day, to-wit: On the thirtieth day of June, 1943, the following further proceedings were had and entered of record, to-wit:

Wednesday, June 30, 1943.

Court met pursuant to adjournment:

Before:

Hon. Evan A. Evans, Circuit Judge.
Hon. J. Earl Major, Circuit Judge.
Hon. Walter C. Lindley, District Judge.

Universal Oil Products Company,
Plaintiff-Appellant,
No. 7912 *vs.*
Globe Oil & Refining Company,
Defendant-Appellee.

Appeal from the District Court of the United States for the Northern District of Illinois, Eastern Division.

This cause came on to be heard on the transcript of the record from the District Court of the United States for the Northern District of Illinois, Eastern Division, and was argued by counsel.

On Consideration Whereof: It is ordered and adjudged by this Court that the Judgment of the said District Court in this cause appealed from be, and the same is hereby, affirmed, with costs.

And afterwards, to-wit: On the twenty-first day of July, 1943, the Mandate of this Court issued to the District Court of the United States for the Northern District of Illinois, Eastern Division.

UNITED STATES CIRCUIT COURT OF APPEALS

For the Seventh Circuit.

I, Kenneth J. Carrick, Clerk of the United States Circuit Court of Appeals for the Seventh Circuit, do hereby certify that the foregoing printed pages contain a true copy of proceedings had and papers filed, excepting briefs of counsel and motion, stipulations and orders pertaining to briefs, in

Cause No. 7912.

Universal Oil Products Company,
Plaintiff-Appellant,

vs.

Globe Oil & Refining Company,
Defendant-Appellee,

as the same remains upon the files and records of the United States Circuit Court of Appeals for the Seventh Circuit.

In Testimony Whereof I hereunto subscribe my name and affix the seal of said United States Circuit Court of Appeals for the Seventh Circuit, at the City of Chicago, this 18th day of August, A. D. 1943.

(Seal)

Kenneth J. Carrick,
Clerk of the United States Circuit Court of Appeals for the Seventh Circuit.

SUPREME COURT OF THE UNITED STATES

ORDER ALLOWING CERTIORARI—Filed November 15, 1943

The petition herein for a writ of certiorari to the United States Circuit Court of Appeals for the Seventh Circuit is granted.

And it is further ordered that the duly certified copy of the transcript of the proceedings below which accompanied the petition shall be treated as though filed in response to such writ.